CADUCEUS

a museum quarterly
for the health sciences

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Walter Miles. (Photo courtesy of Yale Medical Historical Library.)

The Peak of Electromechanical Experimentation in Physiology: A Unique View Through Walter Miles' "Report of a Visit to Foreign Laboratories" in 1920

Excerpts and commentary by
Gordon M. Shepherd and Janice Braun

During the nineteenth century and well into the twentieth, physiology, as with so many other fields of science in the United States, was largely dependent for its development on Europe. In addition to the training sought by young scholars, there were frequent visits by established investigators in order to maintain old friendships, set up new collaborations, and keep up with the latest developments. Some laboratories organized these trips on a quite regular basis.

An example was a series of visits made by members of the Nutrition Laboratory of the Carnegie Institute after its founding in Boston in 1907. Notable among these visits was that made by Walter R. Miles in the summer of 1920. The timing of this particular visit was propitious, being the first in the aftermath of the Great War. Even more significant is the fact that over the course of four months, Miles visited 120 scientists in 55 laboratories in nine European countries. In addition to extensive interviews with the scientists, he took 107 photographs; some of these are portraits of his hosts, many are of the apparatus in use in the laboratories. This material by itself constitutes a valuable record of the state of physiological science in Europe at that moment. The record is the more valuable in that 1920 represented the peak of development of mechanical instrumentation for physiological experiments. In 1922 the vacuum tube was first used for recording potentials from nerves, and

the electronic age was born. Within a few years, new electronic instruments began to replace the old mechanical devices, a process which continued over several decades. Thus, Miles' diary documents with unusual thoroughness and clarity the peak in sophistication of mechanical instrumentation before the electronic age burst forth in the early 1920s.

WALTER MILES: A BRIEF BACKGROUND

Walter Miles was born on March 29, 1885, in a homestead in what was then the Dakota Territories, now the state of North Dakota. He grew up in Oregon, received his college education there, and then came to the Midwest, where he obtained his M.S. in education and his Ph.D. in psychology at the State University of Iowa in 1913. An appointment as Associate Professor of Psychology brought him East to Wesleyan University in Connecticut, where he filled in for Professor Raymond Dodge, who was spending a year at the Nutrition Laboratory setting up experiments on combined physiological and psychological testing of human subjects in different nutritional states. When Dodge returned, F. G. Benedict invited Miles to be a full-time researcher at the Nutrition Laboratory and continue the experiments Dodge had initiated.

In a memoir,[1] Miles makes special note of his early interest in details of instrumentation. At Iowa he used a tonoscope, an invention of Carl Seashore, his mentor, to analyze the accuracy of humans in singing a single pitch. At Wesleyan he absorbed himself in the profusion of instruments devised by Dodge, and developed a keen interest in graphical measurements of performance.

THE NUTRITION LABORATORY OF THE CARNEGIE INSTITUTION

The Nutrition Laboratory was located near Harvard Medical School. The laboratory had several programs of research, one being the effects of alcohol on human performance, and Miles initially became involved in several aspects of this work. The outbreak of The Great War, in August of 1914, stimulated new programs, such as testing gas masks and studying pilot aptitudes. A particularly thorough study was carried out on the effects of severe malnutrition, for its relevance to war-time policies of food rationing. This study involved monitoring of a range of functions, including basal metabolism, heat output, heart rate, blood pressure, skin temperature and nitrogen output. Tests documented decreases in a number of physiological and psychological parameters. The Nutrition Laboratory was but one among many laboratories, both in the United States and on both sides of the continent in Europe, whose

research focused on these kinds of practical problems during the war years, and also into its aftermath.

Thus, by virtue of this range of research experience, knowledge of a variety of physiological and psychological methodologies, and acquaintance with a number of the leading American experimental psychologists, physiological psychologists, physiologists, and medical scientists with whom he rubbed elbows at Harvard and environs, Miles was well prepared to make a trip in which he would be an outstanding representative of his laboratory.

THE NATURE OF THE TRIP

A narrative overview of the trip has been provided by Miles himself, of which we excerpt the following:

> In the spring of 1920 I was scheduled to visit laboratories in England and on the Continent as a representative of our laboratory. . . . Before the war our inter-visitations had been a regular part of the Carnegie program. We felt they were valuable for criticism and suggestions and our friends abroad seemed also to favor the scheme. My tour in 1920 lasted four months, April to August. . . . This was my first trip abroad and how attractive it all seemed to me. The mission was to visit laboratories and scientists and every day was full of interest. . . . These scientists were cordial and wonderful hosts. Friendships began which have lasted through the years; such were the meetings and discussions with E. D. Adrian, Joseph Barcroft, Henry Dale . . . [and] August Krogh. . . . My large book of photographs and notes [i.e., the present diary] has been reviewed and reviewed many times in the years that followed.
>
> At the time of my European trip there were several psychologists who had established laboratories and were willing to welcome visitors. At Cambridge University there was an excellent laboratory. It was a new wing added to the physiology building and at the time Professor Frederick Bartlett was in charge. . . . At Oxford I found Professor William McDougall lately returned from Zurich, where he had worked with Dr. Carol Jung on methods of psychoanalysis, a subject which McDougall had pursued during the war. With McDougall in charge, psychology had flourished at Oxford for a few years. Now with regret Professor Sherrington had, for lack of space, to turn out Professor McDougall and his students from these rooms. . . . I had a cheerful visit in the Physiological Institute [University of Leipzig] conversing with

> Professor S. Garten. We had both worked on similar aviation pilot problems during the war. Now we could shake hands, compare results, and have a beer together. These brief visits made me want to see and know more. I was impressed with some of the strange effects of the war; many of them were in fact psychological phenomena.
>
> At the time I visited these laboratories this type of experience was so new that I thrived on it. . . .
>
> Back in the United States I had much to tell and to show in photographs and collected reprints. My laboratory was still there, no one had taken back the space, and I was contented to be in it again and working.[2]

In reading both the above account and the journal passages, it seems that Miles knew at the time that he was making a significant contribution to the history of his science. He was almost prophetic in his meticulous rendering, for posterity, of the details of the laboratory apparatus, experiments and personalities in his writing and photographs. His enthusiasm for his trip these many years later is equal to that of the young Miles on his inaugural trip abroad.

It is remarkable that there is no mention or feeling of competition between these scientists. Miles seems completely open to this opportunity to observe and learn without the least bit of xenophobia or criticism. Unlike many American tourists, he does not even complain about the food or accommodations.

EUROPE AND PHYSIOLOGY IN 1920

The European trips had been an annual occurrence for the Carnegie Institution, but because of the outbreak of the war, the trips had been suspended for six years.[3] The main reason for the visit, other than to reestablish contact, was to gather advance information on research delayed in publication and to observe laboratory equipment that might never be publicized. Conversely, the European scientists had called on their American colleagues to disseminate scientific publications which were very difficult to obtain as a result of dismal wartime monetary exchange rates. Another purpose was for Miles to act as a kind of ambassador to fulfill the Carnegie's international mission, defined as the "improvement of mankind."

At the time of Miles' visit, the state of Europe could be described to a great extent by the word "chaos." Destruction from the war was still widespread. The Treaty of Versailles had saddled enormous and punitive reparations on Germany. Hostilities simmered and flared out, as in the continuing struggle between Germany and France over the Ruhr, and Poland and Russia in the East. Ministries rose and fell; there was a general strike in Germany in March, and in Ireland in April. Animosities also lingered, expressed to a surprising extent by some scientists in France and England. It is interesting that Miles makes relatively little note of the political chaos, keeping his focus very tightly on the laboratories and people he was visiting. However, hints of the continuing tensions creep into the diary. Exclusion of German and Austrian scientists from the first international congresses of physiologists after the war in Paris and Hamburg was deeply felt, as can be gleaned from Miles' account of his visit with Professor Garten in Leipzig.

A dominant theme in the diary is nutrition. This is partly because of the Carnegie Institute's special interest in this area, but partly also because of the widespread malnutrition and starvation during and after the war. The most vivid images of its effects on the populace are in the visit in Vienna to Professor von Pirquet. Malnutrition was an overriding concern for all the warring nations, however, and many laboratories were drawn into doing studies in one way or another that would improve understanding of the effects of malnutrition and its alleviation.

A related theme concerns effects of alcohol on human performance. This had been an increasingly active area of research in the early part of this century, stimulated in part by the prohibitionist movement in the United States. Prohibition in the U.S. became law on January 16, 1920, so it was a topic very much in the news at the time of Miles' trip. Several of the people he visited had an active interest in this area, including Sherrington in Oxford and Krogh in Copenhagen.

EXCERPTS FROM THE DIARY

The excerpts reproduced here are from Miles' personal copy, deposited in the Yale Medical Historical Library upon his retirement as Professor of Psychology at Yale University in 1953. The diary consists of 256 typewritten double-spaced pages. We have excerpted accounts of visits to 10 of the total of 38 laboratories that Miles visited. For a given laboratory, the account is usually supplied in full. We have included 16 of the original 107 photos; in all cases these relate to the laboratory visited, although not all photos for a given laboratory are included. These particular excerpts and photos were selected to

give a representative overview of the diary contents. The diary concludes with an epilogue ("General Remarks"), which we have included because it gives the rationale for the trip and a summary of the results. Readers may wish to refer to it first for further orientation before reading the excerpts.

The scientists visited by Miles constitute a virtual *"Who's Who"* of many of the outstanding physiologists of Europe at that time. Biographical notes have been included to help orient readers to this remarkable variety of research workers. We have sought to indicate the point they had reached in their careers at the time of Miles' visit, and the nature of the significance of their main contributions to physiology.

NOTES

1. Edwin G. Boring and Gardner Lindzey, eds. *History of Psychology in Autobiography*, vol. V (New York: Appleton-Century-Crofts, 1967), pp. 227-29.

2. *Ibid.*, vol. V, pp. 232-34.

3. Carnegie Institute of Washington, *Year Book No. 19, 1920 (Washington, D.C.: Carnegie Institution, 1921), pp. 269-71.*

AUTHORS

Gordon M. Shepherd, M.D., D. Phil., is a native of Ames, Iowa, where he attended Iowa State University and received his B.S. degree in 1955. After receiving an M.D. degree from Harvard University, he trained at Oxford University in neurophysiology under Charles G. Phillips, receiving his D. Phil. in 1962. Following further research training at the National Institutes of Health in Bethesda, Maryland, and the Karolinska Institute in Stockholm, Sweden, Dr. Shepherd moved to Yale University School of Medicine in 1967, where he is now Professor of Neuroscience in the Section of Neuroanatomy. His primary research interests are in the organization of brain circuits and in sensory physiology.

As an undergraduate, Dr. Shepherd was introduced to the methods of historical research through a student assistantship with historian Norman Graebner. At Oxford he worked in the tradition of Charles Sherrington and either knew or saw Edgar Schuster, Edgar Adrian, C.C. Douglas and Henry Dale, all mentioned in Walter Miles' Diary. Thus began a lifelong interest in the historical origins of physiology and neuroscience. From some of this study has evolved two textbooks, *The Synaptic Organization of the Brain* and *Neurobiology*. Presently Dr. Shepherd chairs the committee on the History of Neuroscience for the Society for Neuroscience, and is co-editor of the History of Neuroscience Series of Oxford University Press.

Janice Braun has been the Assistant Librarian in the Yale Medical Historical Library since 1987. She received her master's degree in library and information studies from the University of California at Berkeley. Her previous position was as an editorial assistant for the Mark Twain Papers, which are housed in The Bancroft Library at U.C. Berkeley. Ms. Braun's professional interests include rare book librarianship, preservation concerns and the book arts.

Leonard Hill and his assistant, Miss D. Hargood-Ash, working with the meter at the National Institute for Medical Research, London. (Photo courtesy of Yale Medical Historical Library.)

National Institute for Medical Research, Mount Vernon (British Medical Research Committee)

DR. L. HILL

Dr. Hill, assisted in his laboratory by Miss Harwood-Ash, showed me his "Kata"- thermometer (which may be purchased from James Hicks Company, 8 Hatton Garden, E. C., London, or the Siebie-Gormon agent in the United States) and had much to say about it as a convenient instrument for measuring the cooling power of the air under different conditions of ventilation. He is especially interested in the problem of ventilation and outdoor air treatment and had published recently, as one of the Medical Research Committee's publications, a monograph which was to be the first part of his contribution to this field. He gave me a copy of this monograph. He is convinced that the comfort of [the] physiological organism working in a room or out-of-doors depends on the cooling power of the air. With Miss Ash he was trying to develop a "kata," as he continually called it, which was heated electrically by a small resistance wire imbedded in the bulb. He heats the thermometer to a certain temperature and then notes the time elapsing while it cools a certain number of degrees. He spoke much about the results obtained in wind tunnels and said they do not agree with results obtained on top of the roof with the wind blowing at the same rate. He thought that the radiation from the surface of the ground probably effected [sic] the cooling power of the air. To my question if he had performed the experiment out-of-doors at night, he answered that he had made no night experiments and thanked me for the suggestion.

Hill hopes to become connected with various factories in the capacity of consultant from the Medical Research Committee and to measure the fitness for work of the employee under different factory conditions. He said he would

use the "Flack Methods," i.e., measure the vital capacity, the length of time that the subject can by blowing hold a column of mercury to a certain pressure, etc., etc. Dr. Flack was away at the time of my visit. Hill thought that physiological tests which involved the tone and fitness of the abdominal wall were of the greatest importance. He referred to the "fundamental nature" of his early work on the abdominal wall and the blood supply and said that it was never cited in current physiological text books. He thought it of prime importance in considering physiological fitness.

Hill favors developing resistance in the physiological organism rather than trying to get rid of all carriers of disease, which latter is the aim of Dr. Benjamin Moore. Hill criticizes the work of the Nutrition Laboratory that all of our metabolism measures have been made in still air. He believes that the metabolic level is raised especially by cold and by wind and this not because of any shivering of the patient or any physical exercise of the patient due to his being in the cold or wind. He thinks this change in the metabolic level to be the benefit of the outdoor life. His hypothesis is worthy of consideration since it is known that outdoor life is favorable to health, to recuperation from tuberculosis, and such conditions, and since it is further known that the oxygen and purity of the air is probably not better outdoors than indoors. He thought the skin temperature of the cheek a good indication of the metabolism and said that by using a large bulb thermometer, moving and turning it a good deal would give a very satisfactory reading of the skin temperature.

I think Hill feels disappointment or lack of appreciation of his scientific work. He referred to his 20 years of teaching at the University of London and how it was necessary continually to "cram" men for examination to get them through so that they will in time be the "Consultants" of the West End. These "Consultants" give their services free to the hospitals to make friends of the young doctors who will later call them as consultants. It is a vicious system according to Hill. The consultants belong to the aristocratic class, they live off the aristocracy and know only about the ills of the aristocracy, never seeing the inside of a factory, or knowing of the ills of the common laboring class. Medical education is not right according to Hill. Physics, chemistry, and biology should be taught in their application to medicine and not by so many separate specialists. Anatomy he thinks is a clear waste of time. The anatomists should be made to teach histology and bacteriology. . . .

This building which the Medical Research Committee is occupying was previously a tuberculosis hospital. They have just moved into the place. It was ready for them in 1914 but was taken over as an aviation hospital and the Medical Research Committee was given temporary quarters at the Lister

Institute. . . . The cooperation of the Institute with factories is entirely voluntary and the investigators have no teaching duties. In a good many ways the Institute resembles departments of the Carnegie Institution.

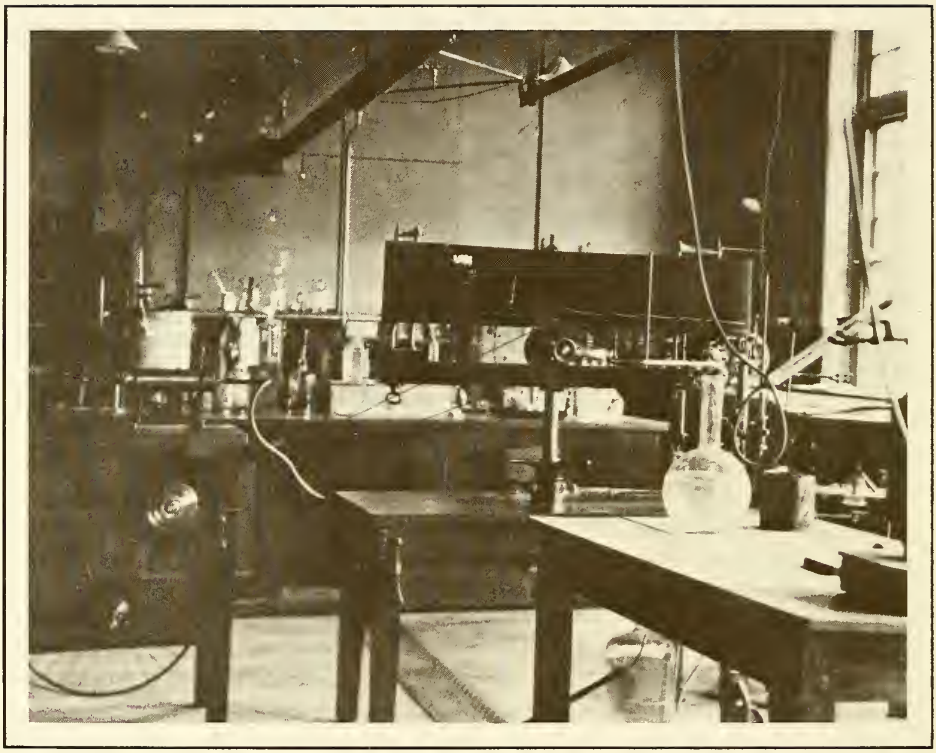
DR. BENJAMIN MOORE

Dr. Moore, the physiological-chemist of the Institute, was studying photosynthesis. His research might be characterized as on the problem of the first origin of the organic from the inorganic. The buds of spring he believes are not hold-overs from the life and energy of the past summer but the result of the manufactured substance of late winter while everything is still brown and apparently lifeless. The brown bark of the trees and shrubs is quite translucent at the points where growth is going to occur and act as light filters to the chlorophyll below, cutting out especially the blue and ultra-violet light. Moore was measuring the spectrums of many samples of bark from tree limbs and shrubs. A second research problem that was interesting him was that of nitrogen fixation. He was growing twigs in different kinds of water and light and measuring the amount of nitrogen fixation by the amount of change in weight. He has a very convenient outdoor room associated with his laboratory.

DR. DALE

Dr. Dale's department of Bio-chemistry and Pharmacology was quite completely equipped and installed. On a rigid beam which ran lengthwise in his main laboratory room and [could] be seen at the top he had many outlets for gas, water, electricity, and time from a Brodie clock. The beam was high enough to offer no obstruction to workers in the room, and tables and kymograph supports could easily be manipulated below it, all wires and rubber tubing extending upward rather than down and about the floor. Below the beam and parallel to it was an opening in the floor for all liquid waste. The laboratory had two relatively new C.F. Palmer and Company's kymographs . . . . [There was] a power table and on this was mounted the artificial respiration pump. A little special room with suction ventilation was arranged for smoking paper and for dipping and drying the records, a very complete installation. He had also a new long paper kymograph with two very small drums at one end. Between these two drums is a flat and relatively firm but large area on which the tracings of large, curved lever movements may be registered. The Palmer kymograph has signal magnets and manometer mounted on it as a part of its regular equipment.

I did not learn of the researches that Dr. Dale had in progress. There was at the same time another visitor, Dr. Alonzo Taylor, of America, whom I was very



H. Dale's laboratory for Bio-Chemistry and Pharmacology at the National Institute for Medical Research, London. (Photo courtesy of Yale Medical Historical Library.)

glad to meet here. He was just returning from an extended visit through Germany and Austria in reference to the conditions of nutrition in those countries. Taylor urged me to visit Vienna and see the work of Dr. Von Pirquet in charge of the children's clinic and the Hoover Food Kitchens.

DR. BROWNLEE

I was shown the excellent equipment of the department of Statistics by Dr. E. Schuster, secretary of the publication department, and Mr. Russel of the Statistics department. They had one of the "Millionaire" computing machines and said it did addition (non-listing), and multiplication for which they considered it the best existing machine. It requires one turn for each place in the result. It does division quite well, but subtraction quite slowly. It is a large, heavy, box-like device. They had the Euclid computing machines both electric and hand operated and said it was especially good for division. There was a large ruling and plotting machine in a special alcove and above this machine a large aluminum cover nicely counterpoised so that the machine would be kept out of dust whenever not in use. It was a Swift machine. A second curve drawing instrument was especially adapted to draw a given curve to a different ordinate value or to change one dimension of a picture of figure. There were two harmonic analyzers both designed and one made entirely by Schuster. It was a beautiful piece of work. I believe Brownlee is devoting himself to medical and vital statistics. His was not in any case a department to give statistical treatment to the data collected by the other men working in the Institute.

DR. SCHUSTER

Dr. Schuster, as secretary of the publication department, edits and sees reports through the stages of proof and final printing and has charge of mailing and all applications for the reports of the Institute. . . .

I was especially anxious to learn about the methods and policies of the Institute. Schuster gave me the set of annual reports and discussed the early organization of the British Medical Research Committee, which now is under the Privy Council. They have no endowment. The budget is a matter of an annual grant. Its amount and the expenditures of the committees are not made public. Each research man is his own boss so far as problems and work are concerned. There is a stock room for the more general supplies upon which they can all draw but for any special apparatus or for the undertaking of any special problem a man must himself go with a requisition direct to the Board

which means to Sir Walter Fletcher. The Board is quite liberal and willing to listen to propositions for research.

If the National Institute for Medical Research, now located at Mount Vernon, Hampstead, continues to receive the support of the British government, it will probably be one of the most important research agencies in England. Its field is very wide and one wonders if it will gradually come to absorb such organizations as the British Fatigue Board, which is interesting [to] Sherrington and also Lee of Columbia University in the U.S.A. Dr. Charles Meyers is trying to establish an Institute for Applied Psychology and Physiology. Sir James McKenzie is endeavoring to establish an Institute for Preventive Medicine, the object being to develop tests and diagnostic methods which can be used to determine the tendency toward certain diseases before they have developed in the individual. It seems to the outside like the National Institute for Medical Research might well be the organization through which all of these lines of research and application of science to medical practice might be carried out, rather than having several institutes with overlapping fields.

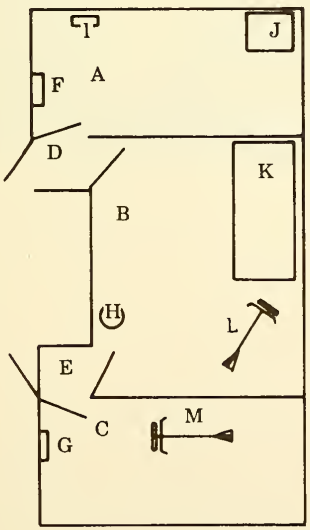
However, among the names of supporters for the proposed new institute we may note those of Sir Walter M. Fletcher, Sir R. A. Gregory, Mr. W. B. Hardy, R. Leonard Hill, Sir Alfred Keogh, Dr. C. S. Myers, Sir E. Cooper Perry, Prof. C. S. Sherrington, and Prof. E. H. Starling. The intention of the founders is to establish a national institute which will investigate the human problems of industry and commerce, occupying a position similar to that held in the domain of physical science by the National Physical Laboratory. It will provide training courses and lectures for those interested in the practical applications of psychology and physiology to the problems of industry and commerce. It will undertake investigations at factories and offices in relation to any special problems. The institute will not be established for profit and close relation will be maintained with the Industrial Fatigue Research Board, but overlapping of effort is to be avoided.

University of Cambridge, Physiological Laboratory

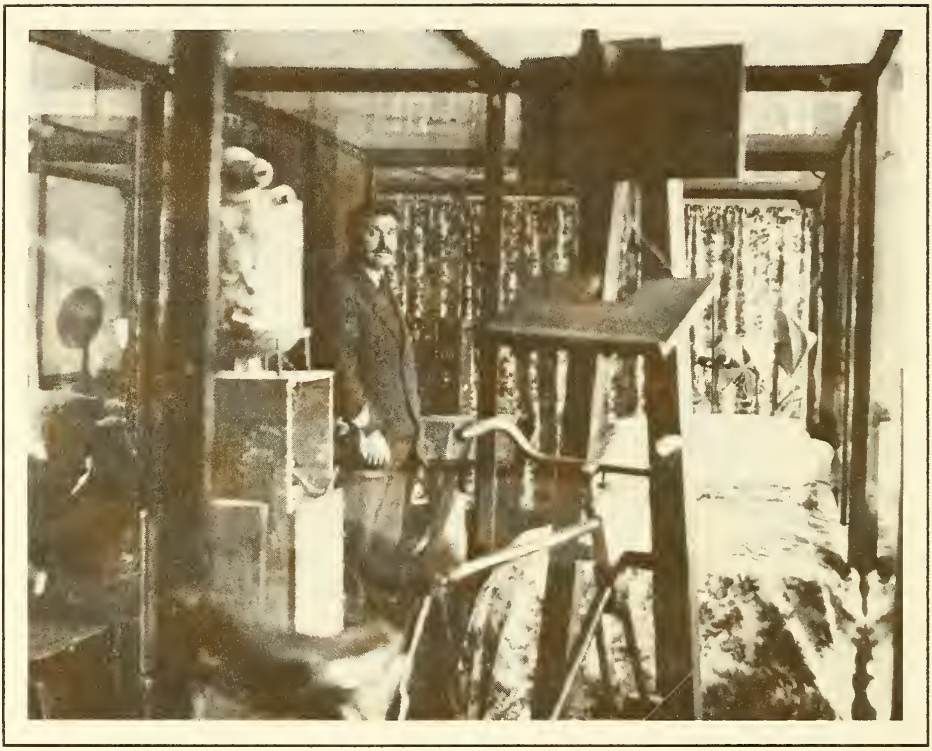
DOCTORS BARCROFT, ADRIAN, AND HARTREE

Dr. Barcroft has recently built a large chamber with glass walls. It is divided into three main compartments, arranged as the sketch below.

SCHEMATIC DIAGRAM OF THE BARCROFT CHAMBER.



A, B and C, three separate compartments
D and E, entrances.
F and G, openings to receive food, etc.
H, large CO_2 absorber
I, Haldane gas analysis apparatus.
J, electric fan.
K, bed for subject.
L and M, Martin Bicycle Ergometers



Dr. J. Barcroft's large, three-compartment, respiration chamber made with glass walls. Mr. H. Secker, assistant, standing in middle compartment. (Photo courtesy of Yale Medical Historical Library.)

The three rooms provide about 1,000 cubic feet in capacity. All the openings are constructed as air locks.

This chamber is suitable for research on oxygen treatment using more than [the] normal percentage of oxygen in the air and also for experiments with low oxygen. Barcroft has recently performed an experiment of the latter type living in the chamber continuously day and night for six days. He did not report to me all the details of the experiment. He has a big absorber bottle in the chamber and an electric fan to keep the air moving. Food was admitted and excrements [sent] away from suitable openings in the base of the chamber. One such small opening can be seen in the lower left-hand corner. The bicycle ergometer was used for exercise and to measure the effects and efficiency for work under the conditions of decreased oxygen. In general the experiment was to ascertain if the lungs actually secreted oxygen according to the theory of Haldane and Bohr. Barcroft and Haldane do not agree in their interpretation of such results.

In the six days' experiment inside the chamber they made some psychological experiments on Barcroft with the assistance of Dr. Bartlett. These related mostly to the efficiency of memory for recall. Barcroft felt quite miserable [during] the last twenty-four hours of the experiment.

I believe it was immediately following the end of the experiments [of] living in the chamber that Barcroft made an experiment in the open room, riding on the bicycle ergometer to determine the difference in the efficiency. In this latter part of the experiment he was breathing outdoor air and exhaling through a mask. He arranged very ingeniously an old hat with the crown mostly cut away for holding in place the accordion tubing from the mask. He referred to this arrangement as the "halo."

Barcroft, like many other of the experimenters in England, was using the Martin Boyle Ergometer for muscular work. This ergometer is made by C. J. Martin of the Lister Institute of Preventative Medicine, Chelsea Embankment, London. It has been described in the Proceedings of the Physical Society. . . . The rear wheel is fitted with an iron rim, rather heavy and having a flat flange of about two inches width. A canvas belt extends around this wheel. From one end of it a cord, passing around pulleys, is taken to the hook of a spring balance mounted upon a board at the top of the upright in front of the subject. A cord from a second string balance mounted by the first one leads over suitable pulley to the other end of the belt. When the rear wheel is turned by the peddles [sic], the scales drawn on by the tension of the belt, which is in sliding contact with the rim of the rear wheel, show a difference in their scale

Dr. E. D. Adrian in his laboratory preparing a demonstration for the Physiological Society Meeting. (Photo courtesy of Yale Medical Historical Library.)

of day, five pounds. The diameter of the wheel, which I believe is five and a half feet multiplied by the difference in the readings of the two scale balances in pounds and by the number of the revolutions of the wheel per minute, gives, as I remember, the foot pounds of work being done by the subject. I have not read the original description of the apparatus nor do I know its constancy. I think, however, that the water content in the belt must vary from time to time and even during an experiment, as prolonged turning of the wheel must cause the belt to get warm and dry out. How much difference this makes in the amount of work figured according to their formula, I do not know. It must make some but the apparatus has a great advantage in its being very easy to arrange and to use. It seems always to be in order and ready at hand. The subject can experiment on himself, at least to the extent that he synchronizes his own revolutions with a metronome the rate of which he knows, and he can see and read the scales as he is in position riding the ergometer.

One subject on which I was interested to get information from Barcroft was that of stop-cock grease for use with the gas analysis apparatus. Dr. Higgins, when returning from his visit to English Universities in 1913, brought back with him a can of Jackson's stop-cock grease, which proved very satisfactory for use with gas analysis apparatus in this laboratory. This was supposed to be available through Baird and Tatlock. Barcroft had some of this grease, which had been given him by Mr. Allen of Baird and Tatlock Company, but Mr. Allen would not sell any of the grease. Barcroft did not know the reason. He informed me that Mr. T. N. Sturgess of the Clinical Department of the University of Bristol had a formula and made up such grease that was very satisfactory. He did not like to ask him what the formula contained but suggested that we buy some of [it from] him and pay him for the formula. Barcroft thinks the stop-cock grease to be made of rubber, vaseline, bees-wax, and paraffin, but is of the opinion that the merits of the grease consist more in the way it is put together than in the actual substances it contains.

DR. ADRIAN

Dr. Adrian's laboratory is in the basement and occupies one large room with a dark room and one or two small adjoining rooms. This part of the laboratory was planned by the late Keith Lucas and most of the instruments there at present . . . have been made and used by him in his remarkable researches in nerve and muscle physiology. Dr. Adrian, who had previously worked with Dr. Lucas, is continuing this field of research very worthily. The physiological [sic] building of Cambridge University is rather new and very adequate for this department. The building was given by a Merchant's Guild of London known as the "Worshipful Company of Drapers." Lucas chose the basement for his

work and he wanted to be free from vibration in researches employing capillary electrometer. I was greatly interested to examine the Lucas apparatus, with which I had been acquainted only through literature. One of his instruments, the pendulum contact breaker, I duplicated with certain modifications in our laboratory. The original Lucas contact breaker of the pendular type is the large apparatus.

Along the sides of the room heavy concrete slabs are arranged which make very splendid tables free from vibration. The room has a cement floor and in the center of the room or wherever was desired Adrian had groups of stone pillars which could be moved. They seemed to be large tile filled with sand and on top of these a very convenient arrangement of thin stone slabs which could be built up to any desired height for experimental purposes. The light passing from the capillary electrometer passes through a small slit in the wall, to the camera which was in the dark room. Here Adrian could work with an exposed plate on a pendulum or other camera device for giving it suitable motion. . . . .

One quite special piece of apparatus in the laboratory had not been described by Lucas. It was a contact breaking device for giving successive makes or breaks as might be desired by the experimenter. The keys were two tuned steel strings on which one contact point was mounted. This contact point was moved outward into contact with the other point and as soon as [it is] released by the cam, breaks contact by its own tension of the string. A series of wheels mounted on the right hand side of the device allowed one to use all of the makes or breaks or every second one or every third or one for every revolution of these accessory wheels. Adrian asked me for the film of this picture for this apparatus and said that he expected to describe it before long and would like to use the photograph.

DR. HARTREE

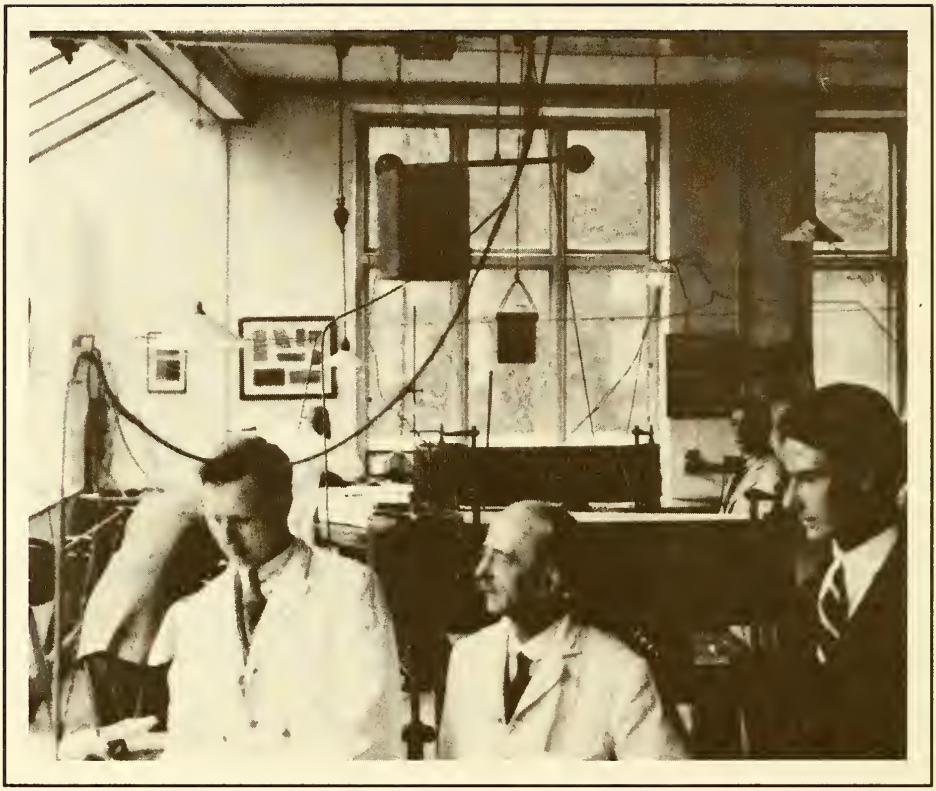
Dr. Hartree is [a] physicist and came to the Department of Physiology in Cambridge to help Dr. A. V. Hill who, for a number of years has been doing most important work in nerve physiology, some of it in collaboration with Lucas and Adrian. Hill has very recently gone to Manchester as professor of Physiology and Hartree is continuing the work in Cambridge under his direction. He is continuing the research on the heat production of stimulated nerve trunks and they have the most complicated set-up of small electrical apparatus with which I came into contact anywhere. Hartree showed me the construction of the thermopiles which they use in their nerve work. The nerve is laid across the thermopile when stimulated and when measuring it for heat productions, due to the passage of conducted disturbances. These thermopiles,

SCHEMATIC DIAGRAM OF THE PASCHEU GALVAMOMETER

A, point of attachment.
B, quartz thread.
C and E, groups of very tiny bar magnets.
D, small mirror.
F, damping vane.

which have been described in some of Hill's articles, are extremely delicate things to make, requiring great care in the cutting of the lengths of the wire and in soldering the two elements together. They embody many turns of wire and I should think a hundred or two soldered joints. Hartree described to me the new type of Pascheu galvanometer which he was using. It is a quartz suspension which is attached at the upper end. At the middle of this fiber is a small mirror which is stuck on and at the end a very small damping vane.

At a point half way between the suspension and the mirror and again half way between the mirror and the damping vane, thirteen very tiny magnetized bits of iron rod are stuck onto the glass fiber. A very slight amount of current [in] the field coils causes the glass fiber to turn. Hartree had experienced considerable difficulty with current leaks into his galvanometer arrangement. We discussed the proper mounting of electrical instruments on dry wooden or porcelain bases and experimented some with his apparatus. It seemed impossible to find the source of his trouble.



Professor Sherrington's laboratory for the course in advanced physiology. (Photo courtesy of Yale Medical Historical Library.)

University of Oxford, Physiological Laboratory

PROFESSOR SHERRINGTON, DR. BAZETT AND DR. DOUGLAS

In Professor Sherrington's department they had the same problem as found in the other universities in England, that is, overcrowding the students at the present time with consequent interruption of research. . . . Although the laboratory building is old, it has been modified in certain particulars and is still quite adequate to the teaching and research needs. The room in which the practical class works is lighted by large windows on two sides and also by a skylight, which is really a continuation of the windows on one side of the room. There are six or seven large long paper kymographs so that twelve or fourteen advance [sic] students can be accommodated at the same time and the working conditions are especially excellent.

Sherrington had quite a lot of new apparatus in process of construction and employs a very good mechanic. He had recently built an elaborate arrangement for successive electrical stimulae. The contact points were mounted on tuned steel strings and arranged so that by electromagnets they could be made to vibrate at the desired rate. The apparatus also employed a number of specially constructed electromagnets which operated armatures somewhat like the piano magnets which we have at the Nutrition Laboratory.

There was in this Laboratory the largest myograph which I have ever seen. It was mounted at one end of the room behind a large glass window which could be raised when the myograph was to be used. As a myograph it leaves very little to be desired, but Sherrington does not like to have his records described on the arc of a circle. It makes the careful measurements of curves difficult in reference to the time line which accompanies such records. He was engaged in devising [an] apparatus which would give him the movement of a

kymograph paper at fairly high speed and in such a way that the record [is] inscribed along straight lines . . . .

Sherrington is a member of the advisory committee of the Central Control Board (of the liquor traffic in England). He is quite keen on the subject of alcohol research and questioned me concerning the work at the Nutrition Laboratory. He thought that a test of static control such as the standing test ws a very good one to use in reference to alcohol investigations on human subjects. He made remarks about the changes in the gait of a man after being given alcohol, also concerning the influence upon vision and upon marksmanship. He suggested that I call at the offices of the Central Control Board (of the liquor traffic), 134 Piccadilly, London, and he gave me a note of introduction to the secretary, Dr. Sullivan. I found later that he had reported our conference to Lord D'Abernon, for the latter wrote me of his conference with Sherrington and asked that I should visit him in London, to discuss the matter if possible. A conference was tentatively arranged , but could not be carried out due to the fact that Lord D'Abernon was sent as British Embassador to Germany, and, at the time I was in Berlin and had gone to Poland, in reference to political matters.

When I was with Sherrington, he said that he knew about my alcohol work and showed me the short paper, the preliminary report given to the National Academy. He made no reference at all to publication 266, although I am certain it was sent to him. It was interesting for me, although possibly just a chance occurrence, to note that he had the short paper on hand, had read it, and referred to certain points in it but the monograph, the longer article, seemed to have made no mark on his memory.

One cannot help but be impressed with the genuineness and kindly eagerness of Sherrington. He is the very [antithesis] of self-assertion and so ready to point out things of interest in your work rather than discussing the importance of his own. His slight tendency to lisp and hesitate in speech only add to the interest with which one hangs on his words.

DR. BAZETT

Dr. Bazett is giving a course in Clinical Physiology, which is on the human side as nearly as possible a parallel [as] Sherrington's course in Mammalian Physiology. He uses or intends to use many measurements on human subjects not only involving strictly physiological functions but also some psychological functions and we found much of common interest for discussion. Bazett is a very earnest and hardworking man. Some of the measurements at present in

use by him may be enumerated: (1) Vital capacity, measured according to the method of Dreyer. Dr. Cairns, an Australian, is working under Bazett's direction in research on the problem of measuring vital capacity. He finds, of course, that the vital capacity measured in liters bears a relation to the amount of CO_2 in the lungs. If the subject makes a deep inhalation preparatory to measuring his vital capacity and holds his breath for a time allowing the CO2 to build up, the amount of air that he is able to expel will be larger and hence his vital capacity measure increased. A second point which Dr. Cairns is working out is the effect of resistance. He thinks that if there is a certain amount of resistance to exhalation, for example, exhaling through a small tube or a tube with cotton wadding in it, the vital capacity measure is larger. (2) Exercise power. They use two dumbbells of ten pounds weight each lifted from the floor to the highest convenient point above the head with arms extended, and measure the blood pressure and heart rate as quickly as possible after the exercise, noting the progressive changes following the exercise. (3) The Flack Blowing Test. The subject blows through one nostril, holding the other closed with his finger and endeavors to hold a pressure of forty millimeters of mercury for forty seconds. The experimenter watches the pulse rate change immediately after the test. Dr. Bazett remarked that they have not found much effect yet but think there is a little difference between the results obtained on Saturday and Monday. He was interested to learn the way in which we, at the Nutrition Laboratory, have commonly taken the electrocardiogram during exercise. (4) The Total Ventilation of the subject per minute for a three-minute test. (5) The Standard Electrocardiogram. Bazett thinks that this may possibly be used for a measure for the dilation of the heart. According to my note, he says that Dr. Cotton has shown that large beats indicate dilation and hypertrophy of the heart. He also refers to the work of Dr. Meakins. A subject of research in which Bazett is especially interested is the time value of the waves of the electrocardiogram and the ratio of these values to the rate. He measures from the end of the T wave to the end of the next T wave for securing his cycle length and finds that from the start of the R wave to the end of the T wave equals .365 times the square root of the time from the end of the T wave to the end of the next T wave, i.e., of the total cycle length. He referred me to the work of Dr. P. H. Dawson, who found the square root function of the carotid pulse, that after a long systole, the diastole is often short, while after a long diastole, the systole is also long. (6) The use of the "Dubosoq" Colorimeter. The above-mentioned tests are selected with a view to measuring physical fitness of a patient.

A line of research in which Dr. Bazett was particularly interested had to do with the keeping for a long time of decapitated animals, for the study of a variety of physiological problems. He was using cats and found it possible to

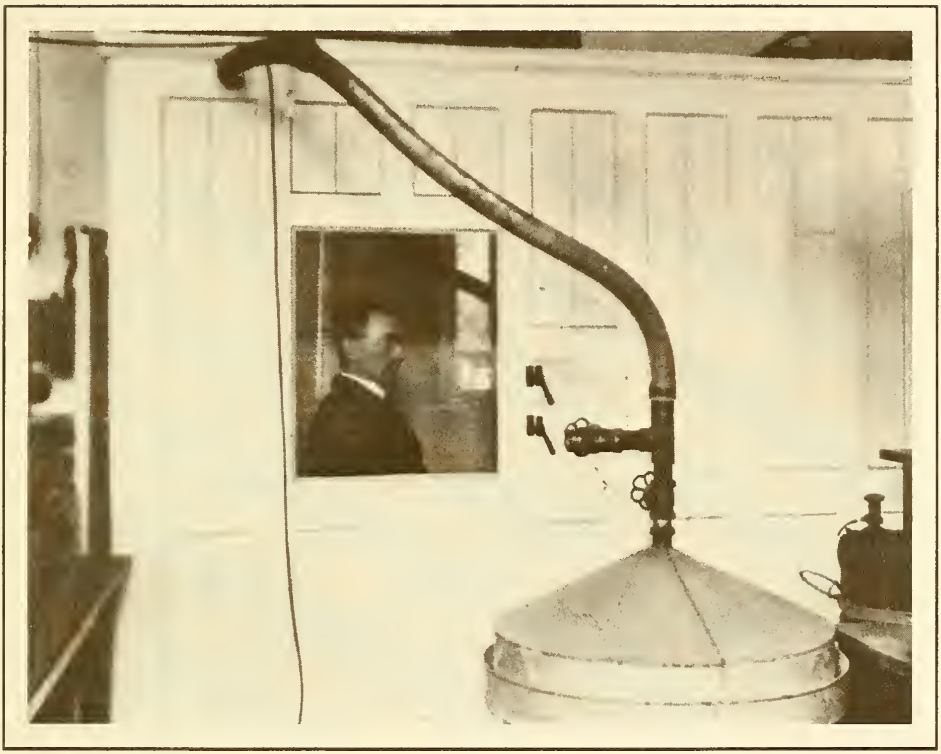
put the animal in a vessel which was floated in a water bath maintained at a relatively constant temperature. He used a rectal thermometer in connection with one of the Cambridge Instrument Companies thread-recording galvanometers, to obtain continuous records of body temperature.

During the war, Bazett did considerable work on problems with the personnel of aviation. He was particularly concerned with the cardiovascular reactions of the pilots. He is well acquainted with Boston, having worked a year or more with Dr. Porter at the Harvard Medical School. I found as many problems of common interests with Bazett as with any other one man whom I visited during this trip.

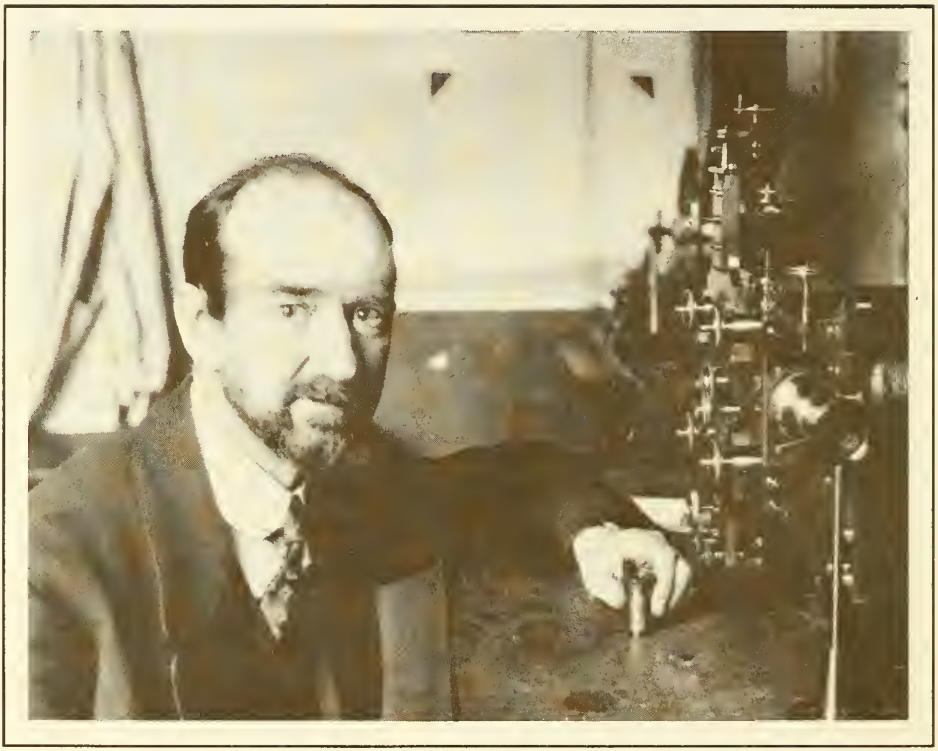
DR. DOUGLAS

Dr. Douglas showed me the apparatus and methods which he had recently employed in his study entitled "Respiratory Exchange of Man During and After Muscular Exercise." In this he had used four "Douglas Bags" in succession, mounted conveniently upon a rack and had employed the bicycle ergometer for the muscular exercise. I saw his large respiration chamber. Its relative size can be fairly accurately judged by comparison with Douglas sitting at the window inside the chamber. It is lead-lined and has two doors, one large and one small. The air enters at the bottom and is sucked out at the top passing through the large absorber shown in the figures. Aside from this chamber, I judged there was no new apparatus in Douglas's laboratory with which my colleagues had not already become acquainted.

Douglas recommended especially that the gas sampling tubes should be mounted on a rack and joined together according [to the drawing], using one outside bulb of mercury. He had found this arrangement much more economical of mercury and very practical when later making gas analysis. . . .



Dr. Douglas sitting inside his large respiration chamber. A reflection in this picture gives the appearance of an outside window at the back. (Photo courtesy of Yale Medical Historical Library.)



Dr. L. Bull making some adjustments on a large string galvanometer of his design at Marey Institute, Paris. (Photo courtesy of Yale Medical Historical Library.)

Marey Institute

DRS. BULL AND NOGUES

My first question after meeting Dr. Bull was to ask him about the report he made to the Societé Scientifique d'Hygiene Alimentaire and of their progress in building a calorimeter. I was astonished to learn that Bull, although returning to France approximately more than six months before the beginning of the war, was never asked to make a report. I understand him to say he was invited to attend one of their board or council meetings following his return, that they went with all his material both pictures, diagrams and notes, but was not called on or given an opportunity to make a report and since had never heard from them.

During the war, Bull's scientific ability was used in developing the sound-ranging apparatus employed by the British on their front. The problem was suggested to him by a man who visited the laboratory with a scheme for using several men in listening posts as reaction agents, each one pressing a separate reaction key when he heard a certain enemy battery. This man thought that with trained observers for reacting [to] the time difference between the reaction signals marked on a kymograph would allow them to calculate the position of the enemy gun. It was only natural that Bull should think of a method of using the string galvanometer for this purpose. (See the photograph of Dr. Bull with a large galvanometer of his design.) Hence he arranged a galvanometer with six strings, each string connected to a microphone. The microphones were placed in a linear arrangement more or less fronting the expected position of the enemy's guns and each microphone was [a] considerable distance from its neighbors. A preliminary trial was made at the Marey Institute, early in the war in the presence of some of the French generals. At this time they located the gun, which was about five kilometers away, to within five meters of line and ten meters of distance.

In the firing of a piece of artillery, there are two distinct sound waves, one made by the explosion of the gun (at the muzzle of the gun), the other by the flight of the shell. In the preliminary trial, a blank charge was fired, no shell passed through the air. It so happened that later, when they tried actually at the front, they had absolutely no success at first. It was because the sound waves produced by the shell flight entirely disturbed the record. Much time and effort were spent in developing a suitable microphone which would be sensitive to the wave from the muzzle of the gun, and not to the wave from the flight of the shell. This part of the apparatus was finally devised by a Mr. Tucker of England. In principle, his microphone is a box resonator with a hole in it and a glowing platinum wire or grid stretched across this hole. The wave created by the explosion at the muzzle of the gun is of large amplitude and causes a movement of air which is sufficient to cool this glowing platinum wire and produce a quick current change, causing a deflection in the galvanometer. The string galvanometer, a lamp, camera, switch-board, etc., were all mounted on a panel about a meter square, and the whole thing was in the control of a scout. This scout had a position in front of the microphones so that when he himself heard the sound wave, he could, by pressing a button, set the galvanometer and everything in operation. He waited until the sound wave had swept past the microphones and released the button. The attendant in the motor car with the apparatus had only to cut off the film, develop it and hand it over to those in charge of the gun fire. Bull said the gun could be located as accurately as in their first trials and within three minutes of its discharge.

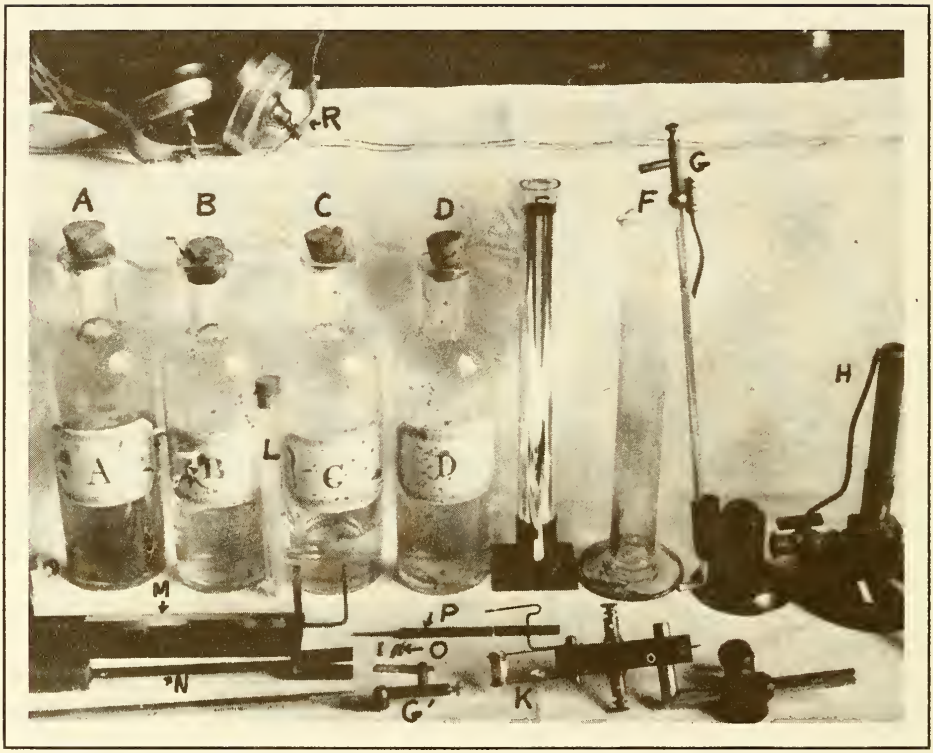
The British Army had such an outfit located every three miles on their front. They used no other apparatus for this service. The French used this arrangement and also one other type at the same instant, making it so that the record from that microphone was worthless, the other five microphones would give sufficient data to locate both guns. I learned that Mr. Tucker had received £. 5000 for his microphone from the British Government. The Tucker Microphone was patented, but Bull's arrangement was not. He had made a claim to the British for financial remuneration for inventing the method of perfecting the rest of the apparatus.

Quite a number of the string galvanometers and parts of the apparatus were manufactured in the machine shop at the Marey Institute during the war. The profit of this enterprise is now what keeps the Marey Institute going. Their regular income is 25,000 francs, the same as before the war. They have five people working on full time. With the profits from the manufacture of instruments, they will be able to carry on for about eighteen months, at the end of which time, they will be at a financial crisis as an institute. Bull, as assistant director, is practically entirely responsible for the work of the Marey

Institute at present. He informed me that all the chief governments of the world had sent them work of some character, with the exception of the United States and the British Government. Bull told me that the British Government is now disposing of these sound-ranging outfits and he advised, if possible, that we secure one of them, as the apparatus would undoubtedly be useful at some time or in parts.

Another large research, which Bull has on hand and which grew out of the war is the matter of photographing the flight of a bullet as it leaves the gun. He has developed a technique for taking 20,000 to 50,000 pictures per second of the bullet as it passes from the gun. He has arranged so that a large electrical condenser discharges through a very small condenser. When the charging of the small condenser has reached a certain tension, it discharges by a spark across the terminals then the condenser is again charged and discharged over and over with a rapidity of such values as mentioned; i.e., 20,000 to 50,000 times a second. It is, I think, called the "bucket" method of discharge. A strong current of air must be blowing between the terminals so as to sweep away any luminescent particles that might remain there. Bull tried to measure the duration of one of these discharged sparks by an arrangement of revolving mirrors. In place of moving the film he, by the revolving mirror, switched the beam of light and got 5,000 meters per second of movement. Even with this terrific speed, the image of the electric spark is, he said, entirely sharp, indicating that it has not been distorted by this movement of the light beam. So far as he has been able to prove, the spark is absolutely instantaneous. I can not understand how it is possible.

Bull has devised a special camera for working in this research. The wheel that carries the film is 16 cm. in diameter. Both edges of the film thread into slots so that it will not fly off the wheel. The speed of revolution causes the film to move at a rate of 300 feet per second. The slit of the camera, the muzzle of the gun and the discharge points of the condenser are all at the same level. The recoil of the gun closes a key and causes the large condenser to begin to discharge. The latency for the condenser discharge is about the same as the time duration from the moment the bullet leaves one end of the barrel and gets out of the other end. The bullet passes between the sparks and the camera; when out of range it cuts a fuse wire, thus breaking the circuit [and stopping] the condenser discharge, the picture is therefore its shadow in various positions. The picture is so sharp that the individual grains of powder which come out of the muzzle of the gun, unburned, are exceedingly clear cut. It is the burning of these unexploded grains of powder which makes the flash at the muzzle of the gun. Bull was greatly interested in some account of the apparatus, arranged by Mr. St. Claire of the General Electric Company [in]



Details of apparatus used by Dr. Bull in drawing and silvering glass strings for the string galvanometer. (Photo courtesy of Yale Medical Historical Library.)

Lynn, for measuring the time of the bullet's passing through the gun barrel. He would like for me to send him any details that Mr. St. Claire is willing to supply regarding this apparatus.

The work was in progress with a common army rifle at the time of my visit. He had a simple sandbox at one side of the room in which the bullet imbedded itself after being fired. Previously, he had been working with small field artillery, I believe, a three-inch gun. He had a temporary building in front and to the left of the Marey Institute and a very substantial gun pit made of stone work which is located rather near the Marey Monument.

Bull very kindly demonstrated for me his method of making and silvering glass fibres for the string galvanometer. I remember he did some work along this line while he was visiting Nutrition Laboratory in 1913. [The illustration] shows all of the apparatus which he required for this technique. The various items are as follows: (A) solution of distilled water and nitrate of silver, the "Fondu form," i.e., not crystallized. An 8°/solution is used. (B) solution of distilled water and pure ammonia. A 20°/solution is used. (C) a solution in the proportion of 25cc. of distilled water, 7.8 grams of white granulated sugar and 3.125cc. of 90°/ethyl alcohol. (E) is a tube in which to do the silvering of the strings. (F) a graduate, for measuring the solutions. (G) a holder for the glass fibres to conveniently manipulate them and place them in the silvering tube E. (G) a second holder for manipulation purposes. (H) a Bunsen burner with a pilot light, very convenient. (K) the small electric furnace in which the glass rods are melted so as to draw them out into a thin string. (L) a tube of small glass rods ready to be used to make strings. (M) a holder in which with the help of the soldering iron (N), to solder the strings to the small pins (O). (P) a small polished boxwood stick for polishing the strings after they have been silvered and have become dry. (R) a telephone set which, in combination with a dry cell, is used to test the strings for conductivity.

The small glass rods are of ordinary glass, about the diameter of a pin and four inches long. One end of the rod is melted, so that a small ball is formed. The electric furnace K, although not clamped on a support, is shown in the proper position. The arm at the top is slotted so as to catch this ball made on the end of a glass rod and to support the rod so that it will hang free inside the electric furnace. The rod extends about two inches below the furnace. A small hook is made on the rod by melting and turning the glass and on this a little bit of copper wire or some small weight is suspended. The electric furnace is supported about five feet from the floor. The current is turned on, one watches the glass rod and endeavors to turn off the electric current at such a time that the glass will have elongated to about four feet. The lower part, bearing the

small weight of copper should not bump against the floor. A bit of shellac, touched to the upper horizontal bar or G and then touched to the string immediately below the electric furnace, allows one to break off the string and to carry it about. The string does not go floating through the air since it is taut by the weight hanging below. Then one winds the string over the lower horizontal bar of G and brings it back to the upper one, thus having provided two strings of proper length for silvering and both on the same frame. . . .

When the strings are to be soldered to the points which mount in the galvanometer, a very small piece of paper is touched with shellac and fastened to the lower end of one of the strings while the string holder is held in an upright position. . . . Then the string is cut below the point of attaching the paper. This makes a small weight which holds the end of the string down and does not allow it to fly about. On the frame M, which holds the pins, when the string is to be attached, there is at the extreme right, a small moveable arm. By a bit of shellac, the upper end of the string is attached to this moveable arm. Then one can, using the weight of the paper on the other end of the string, manipulate so as to lay the string across the two pins to which it is to be soldered. A small amount of "Woods metal" solder is placed on top the string at each point and the soldering copper N is warmed. The copper is not placed in contact with the solder but, since it has a slot in it, is slipped around the supports on which the pins are clamped. This warms up the support and the pin and thus causes the solder to melt without the [sic] danger to the string of directly touching it.

The clamps which support the two pins are insulated from each other and by using the telephone receiver in series with one dry cell and attaching one side of the circuit to one of the clamps and touching the other alternately, one can easily test by ear whether the string is electrically conducting. It is Bull's opinion that usually the strings for the galvanometer do not need to be made according to the method of William, by bombarding the strings with silver or gold particles in a vacuum. It is not necessary for them to be so smooth as this method provides. The air damping which is resultant from the strings being somewhat rougher, as is the case when it is silvered by chemical deposit, is not enough to introduce an error in the usual use of the galvanometer and Bull thought it was quite terrible to think of paying as much as $20.00 or $25.00 for a string.

Bull had a number of mechanical and optical things that interested me greatly. One of these was a recent addition to his splendid high-speed camera for use with the string galvanometer. This camera is made on the principle that a piece of film is wrapped around a drum and this drum is given a high

speed. When the film which has a length corresponding to the circumference of the drum has been exposed, the drum must be taken out and the film changed. Bull desired to take a long record of a spiral nature of this single piece of film. He, therefore, needed to arrange a small opening in front of the slit and have this opening gradually pass from one end of the slit to the other end and thus expose the whole film spirally and this required that the image of the string should all the time be kept on the moving opening. Immediately in front of the small opening which travels across the length of the slit, he mounted a small right-angle prism. A second prism he mounted at the end of the slit in such a way that it does not move. The image of the string from the galvanometer falls on this second prism and is reflected from it to the other prism which moves across the field and from this prism is reflected to the film. This arrangement Bull calls an "optical train." This allowed Bull to take a very long high speed record in standardizing some tuning fork for a certain commercial company.

There was a fine magnetic clock made by a concern in Paris, which will operate from two to six years without adjustment or attention. Before the war they cost about $20.00. Bull has arranged that the pendulum of this clock carries a small convex mirror and immediately in front of the lowest point of the pendulum swing, a small magnifying glass is located. The clock is at the end of the room above his camera. A tiny pin-hole in the house of his arc lamp passes a beam of light so as to fall upon the convex mirror carried on the pendulum. This beam of light, as it passes the lens, on the frame of the clock, is reflected to the slit of his camera and so gives him an accurate time line for standardizing purposes. He has a very small, simple wireless receiving set by which he can get the wireless time signals and assure himself from week to week that the clock is accurate. He finds these arrangements very convenient for standardizing purposes.

Their storage battery at the Marey Institute is made up of 36 two-volt cells, each is wired to a pair of mercury cups in a horizontal board. By connecting up these mercury cups they can secure six, twelve, or seventy-two volts in the wiring over the building. The connection is most simple. There are several boards very clearly marked which have different arrangements of contact points, and by laying one of the boards upon the switch board, these contact points dip into the mercury cups and provide automatically for the voltage which is designated on the board. Any boy can go to the battery room and change "boards" to give the voltage wished by the experimenter. [The] arrangement is fool proof.

The machine shop at the Marey Institute is equipped only with foot-power machines, which was a surprise to me.

At Dr. Bull's residence, I had an opportunity of seeing the collection of stereoscopic views which he took at the Nutrition Laboratory in 1913. These views were mostly of calorimeter number three, which he was at that time investigating with a view to duplicating that apparatus in Paris for the Societé Scientifique. These stereopticon photographs were on glass and were viewed by transmitted light. I think I never saw any pictures which more accurately portrayed apparatus. Such pictures would be invaluable as an accompaniment to diagrams if one were trying to duplicate an intricate apparatus. Their chief merit is in making clear the perspective especially when viewed by transmitted light. In this regard they are, I think, just as good as an actual small model which is meant for viewing rather than for mechanical operation.

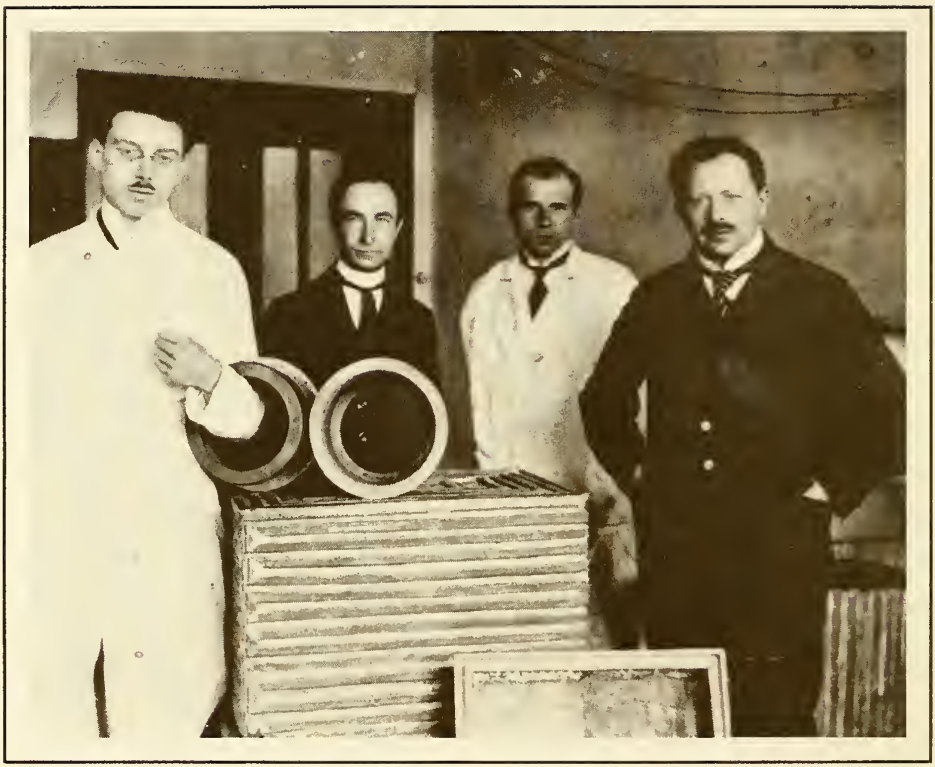
Dr. Nogues is continuing the work with high speed motion pictures of human subjects. He had lately arranged a camera which he showed me. It outwardly looked very much like any motion picture camera but would take pictures at the rate of 300 per second, in open sunlight. The picture taken of athletic events with this camera and projected at the normal rate are highly instructive in regard to the mechanics of physical motion. He has, I believe, gotten his camera so that it is a commercial proposition and can be used for certain scientific investigations in industry or for matters of providing films for entertainment. His latest work is to produce stereoscopic motion pictures and the last day of the Physiological Congress he asked me if I could conveniently come out to the Marey Institute and see a demonstration which he was going to give. I did not learn full details but believed a great deal of the stereoscopic effects is produced by the specially designed screen on which the pictures are projected. Dr. Nogues has a small machine shop in one of the upper rooms of the Institute and does most of his own machine work. One of his special interests and lines of research is the shape of air and water propellers. Dr. Nogues is a doctor of medicine.

I have gone into considerable detail concerning my visit at Marey Institute. It is a place where details are all most instructive. Also it is a purely research institute and hence of special interest.

Catholic University, Physiological Laboratory

PROFESSOR NOYONS

Professor Noyons was for ten years an assistant to Professor Zwaardemaker in Utrecht. The assistancy here paid him very little and he made his living through the practice of medicine. . . . In 1911, I believe, he was approached with regard to accepting the chair of Physiology at Louvain and after a year, made up his mind to accept that position and went there in 1912, during which year he built a very nice residency for himself. One of the conditions under which he came to Louvain was that he should be allowed to build a new physiological laboratory at that University. After a visit to other physiological laboratories, particularly that of Professor Hamburger in Groningen, he completed his plans for the new laboratory of Louvain and the foundation had been laid for the structure and the walls were up to about the first story when war broke out in 1914. Furthermore, he had purchased a good deal of apparatus or had the orders placed and he had received the money from the University authorities for the purchase of these materials. As a physician he had been first assistant in the Louvain city hospital. With the beginning of war the head of the hospital went into the Belgian army and Noyons, being a neutral (a Dutchman) and so having not to do military duty, came into position as head of this hospital. He, therefore, was in the city of Louvain during all the war and as head of the hospital and neutral professor in the University, occupied quite a strategic position. He perhaps has had the best opportunity of anyone to gather unbiased data concerning what actually happened at Louvain during the German occupation of that city. He should, I think, through some agency, such as the Lowell Institute, be invited to give a course of lectures and so put this material in shape for historical record. I found him a man of very open mind without a spirit of hate and I thought him quite unprejudiced in his general view point. He told me it was his opinion that the



Professor Noyons (right) and Dr. Libbrecht (next) with assistants in their shop. The two round objects are shell cases being made into respiration chamber windows. (Photo courtesy of Yale Medical Historical Library.)

burning of Louvain might easily have started by someone discharging a gun accidently. . . .

It was forbidden, of course, in Louvain to have copper, lead, glass or building materials of any kind. Without special permit, however, Noyons, without asking any questions, proceeded to continue his building of the Physiological Laboratory. Most of the other buildings in the neighborhood and most of the University buildings were by this time burned down. No man of military age or fitness remained in the city. He employed others, many of them not skilled in the things which he desired them to do, but he taught them how to lay bricks and how to proceed with his building. He superintended their plumbing, they built all their furniture, and in one way or another, secured and installed apparatus. This he did at times when he could leave the hospital. I think that the building of the Physiological Laboratory at Louvain during the war while the Germans were occupying that city and with the city practically in ruins (there were only nineteen houses standing on the longest street in Louvain, a street some two kilometers in length) is one of the most remarkable achievements which came under my notice. Due to the war conditions and the fact that the laboratory had to make things rather than to buy them, this Institute is equipped in a very practical way and I think that Noyons has been extremely successful in taking advantage of the good points in the arrangement of other laboratories and in combining these and adding certain things of his own origination. He had a group of three young men with him, Dr. Libbrecht, instructor, and Mr. Fauville and Mr. Bouchert, all very keen and working tremendously to get things going and to promote the interest in physiology in Louvain. One wing of the building devoted to physiological chemistry was not yet occupied. The professor in this branch has just been selected, Professor F. Malengreau. On the attic floor of the Institute the books which had been given to the University Library were stored temporarily.

Noyons was having constructed in his shop at the time of my visit a small differential calorimeter for use with dogs and smaller animals. Parts of this are shown in [the photo] with the men. . . . Fauville is holding on his arm a German shell which has been cut off and a hole made through the bottom to adapt it for a window for a respiration chamber. The group are standing about a small metal box on the outside wall of which flat tubes have been soldered so that water can be circulated in them for controlling the inside temperature. The lid is standing down in front. A second similar chamber is shown behind Noyons. On one of these chambers the animal is placed while in the other electrical resistance wire is used to produce electrical heat to compensate in the galvanometer circuit the heat produced by the animal. The two chambers are mounted side by side so that their environmental condition will be as

Professor Noyons balancing electrical heat against animal heat in his large differential calorimeter. (Photo courtesy of Yale Medical Historical Library.)

similar as possible. They are ventilated in the same way and the temperature of the water in the pipes of the walls of the chambers is as nearly the same in both as possible. Noyons brought this small calorimeter complete to the Paris Congress and demonstrated it there. In principle it is the same as his large calorimeter.

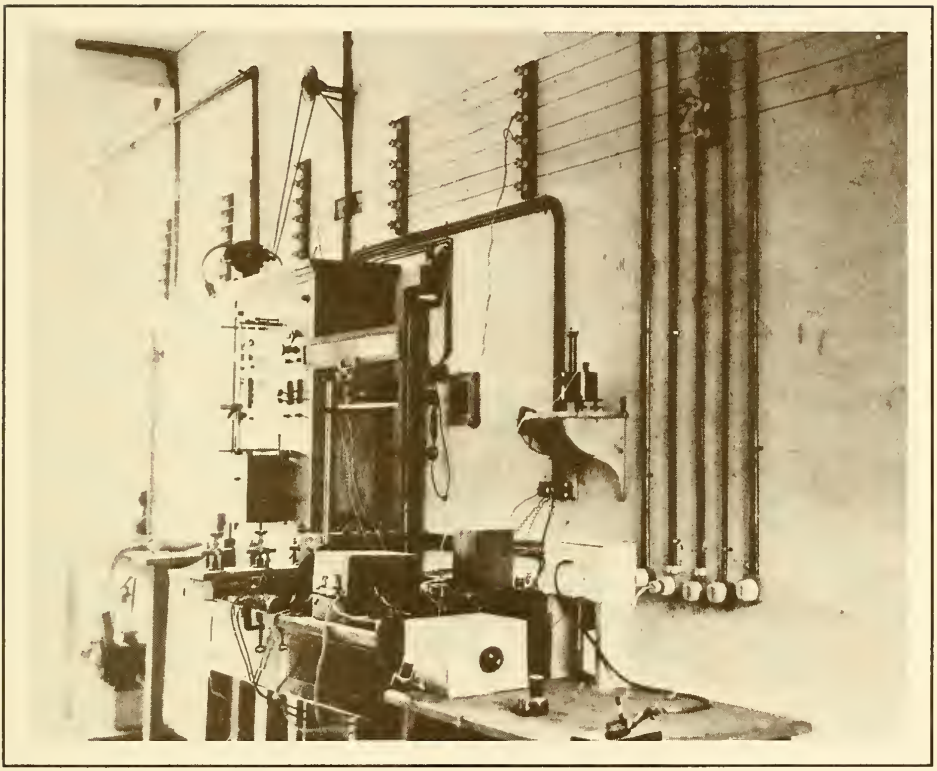
In connection with Noyons communication to the Congress in Paris, he used four charts to explain his larger calorimeter. These four charts I have photographed . . . [one illustration] shows the ground plan of the differential calorimeter at Louvain. This is located in a large basement room of the Physiological Institute, which room [sic] is devoted entirely to the calorimeter and was designed for that special purpose. Up to the present time, Noyons has not had an opportunity to fully work out his results with his calorimeter nor to describe the apparatus. Under these conditions it seems to me best that I should not make measurements and go into too many details in reference to the calorimeter at the time of my visit. I informed him that Dr. Benedict had made and had had in operation for some years a differential calorimeter for small animals, that he controlled the environmental temperature by blowing air over the chambers and used electric heat on one side to counterbalance animal heat on the other. I said nothing to him about his integrating meter arrangement. [An illustration] shows the schematic side elevation of the calorimeter. The floor of the basement room as especially designed and fillers located on which to build the two chambers X and Y. I judged that each chamber X and Y is about 2-1/2 meters long by 2-1/2 meters tall and 1-3/4 meters wide. This I mean to be clear open space not counting the space occupied by the pipes and by electric wires on the wall. The two chambers enclosed by a series of walls beginning at the extreme outer wall A . . . we have to double wooden walls, B is an air space, C a cork wall, D a wooden wall, there being a dead air space between C and D, F air space and H the inside wooden wall to which is fastened the lead lining, I. On this lead lining secured by porcelain insulators are the water pipes K and on top of these a distance of three or four centimeters from the wall is a layer of wire gauze L. This takes up the heat very readily and communicates it to the water pipes.

It was Noyons' original plan to measure the heat production of the animal organism by the change in the temperature of the water in the two chambers, hence the apparatus was built to work on this principle. He later developed the idea of using electrical heat on one side to counterbalance animal heat on the other and now uses the water pipes only to control the environmental temperature. The air is kept moving in each chamber by the fans M and N, which are driven from the same motor and by the same sort of belt system P so that their speed will be uniform. The doors opening into the two chambers

from the hallway Z are exactly the same size and space similarly. They are large enough for a man to walk in by stooping a little. Both chambers must be lighted artificially. There is a glass in the door of each chamber and the light hangs equidistant in the hallway Z. It is arranged to be moved in the hallway but so that it cannot be placed nearer one chamber than the other. At present there is no arrangement for collecting the expired air. It is Noyons' plan to make it into a respiration calorimeter.

The subject enters the chamber on the side designated as S. . . . The outer shell of the calorimeter has in it certain openings whereby it may be ventilated. These are seen . . . also as two square windows in . . . a photograph of a chart showing the arrangement for ventilating and regulating the temperature of the calorimeter. In two of the direct photographs . . . these square windows appear. The control apparatus is on the rear side. . . . This consists of an arrangement for measuring the temperature of the water in the pipes of the two calorimeter chambers and for regulating this temperature either by the use of an anomia refrigerating plant, a small one, which is shown under the bench and at the left hand side . . . or by putting warm water into the pipes of the chamber. Noyons claims that he can make experiments, regulating the environmental temperature from that which would correspond almost to freezing to that which would be torrid. The ventilating pump is seen under the bench in the photograph of the chart . . ., also in the direct photograph, where Noyons is shown in the picture balancing the electrical heat against the animal heat. In combination with the ventilating system they use a "Rotamesser," which gives a continuous indication of the number of liters of ventilation per minute, a very useful instrument for such work.

The arrangement of the water system of the calorimeter and also of the electrical measuring features is shown in schematic outline [and in these photographs] something of this nature can be judged. An exact description of all details of these features of Noyons calorimeter must await the publication by himself. He showed me some charts of results which correspond beautifully with theoretical computation. As a matter of a demonstration we found that the two chambers balanced each other in temperature when they had been unopened and no subject had gone inside. The galvanometer was zero. After placing a subject in one of the chambers and applying electrical heat to the other to compensate the heat given off by the subject, we found it possible to secure a balance within a period of five minutes and so be able to compute the heat production of the subject at that time. Noyons thought it would be quite possible to give five-minute or even three-minute periods with his instrument and by using one of the Cambridge thread recording instruments he plans to be able to get a continuous record of variations during sleep. It seemed to me



The electrical control apparatus of the differential calorimeter. (Photo courtesy of Yale Medical Historical Library.)

that Noyons' apparatus was quite practical for attacking a number of problems and I should expect that a considerable amount of first-class work will come from the Louvain Laboratory in the near future, and that this place will be one of special interest to visitors from the Nutrition Laboratory, and for other American workers in the same field.

Noyons desires to develop techniques which will give him continuous records. For measuring the carbon-dioxide production he plans to use the Ziss Refractometer and to read off continuously the amounts of CO_2 in the expired air from the amount of refraction in these calibrated instruments using one instrument with a standard amount of CO2 as a comparison basis. Noyons, with one of his assistants, was working on an electrical method for testing chemical solutions. This involves the use of selenium cells. Two such cells were placed a given distance from a known source of light. In front of these cells square glass vessels such as are used for optical purposes were arranged to be placed with liquid in these glass vessels so that the light would have to pass through the glass vessels to fall on the selenium cell. They then measure the amount of change in the electrical resistance at the cell, which is caused by passing the light through a certain solution of some substance, and so they measure electrically the quantities of this substance in the solution.

They have much apparatus for working with olfactory and auditory sensation, and in fact with all kinds of sensory physiology, since this is a field in which Noyons has naturally received much training through his working with Professor Zwaardemaker. Noyons also had developed a measuring arrangement for determining the percentage of two gases which were being mixed. This he expected to use in the study of olfactory sensation and he was interested to learn of the apparatus developed by Hanson. . . .

They had in process of construction a respiration chamber about two meters square made of sheet iron, the top . . . slanted like the roof of a house. It had been built so that a partition could easily be placed directly through the center, thus reducing the volume of the chamber exactly by half for certain comparison experiments which Noyons said he had in mind.

One of the basement rooms was arranged for an electrocardiographic room. (All of the basement rooms were light, the windows being practically full size. The street in front of the Institute is somewhat higher than the ground level so that one walks in from the street nearly on a level with the first floor. The building sets back a short distance from the street and thus gives plenty of light to the basement windows.) While the room has white walls, the windows were arranged so that they could be absolutely closed to darken the room. The

string galvanometer arrangement is duplication of that made by Dr. Salomonson of Amsterdam. The room has two large pillars . . . which are specially built for receiving string galvanometer apparatus somewhat like the pillars built in the laboratory of Einthoven. The top of the pillar offers space of about one and one half by one meter in areas. The arc lamp, a large 20 ampere Seimens & Halski lamp, sat at one end of the pillar. About the string galvanometer a cabinet has been arranged with many windows which slide up and can be taken out when desirable. The glass top is not taken off. This exposes the galvanometer and accessory apparatus and makes it easily accessible during periods of use but keeps it free from dust at other times. (Einthoven has large metal covers which are raised up to the top of the room during the day and lowered covering the whole apparatus table at night. These are opaque. Salomonson covered his apparatus with heavy paste board boxes made for the purpose.) The pillars on which the galvanometer apparatus is mounted are unique in having openings below the top slab, which allow for placing of storage batteries and accessory apparatus as needed. This is very useful and in no way detracts from the necessary solidity of the pillar for the purpose of holding the galvanometer.

The string galvanometer is not just like the large one in Salomonson's laboratory but shows some resemblance. . . . The camera is the regular large falling-plate design made by Salomonson. It is quite large as can be judged by the photographs but very satisfactory in its operation, in fact, so satisfactory that Professor Einthoven has adopted it for use in his own laboratory, and I do not remember seeing any other kind of camera at that place. A shallow groove around the top edge of the pillar is useful to keep small parts and tools from rolling off the pillar when one is working with the apparatus.

I should encourage anybody intending to plan or build a new physiological laboratory to visit Noyons and his new Institute. I think that in some ways it is better arranged and more practical than the one built by Professor Hamburger in Groningen and this is saying a great deal. Noyons is undoubtedly a remarkable man in his ability to plan and build. It is to be hoped that he will demonstrate equal originality and versatility in the production of scientific results.

Professor J. K. A. Wertheim Salomonson in his electrocardiographic laboratory at the Neurological Institute, University of Amsterdam. (Photo courtesy of Yale Medical Historical Library.)

University of Amsterdam, Neurological Institute and Laboratory

DR. WERTHEIM SALOMONSON

Dr. Salomonson is an extraordinary combination of the electrical engineer, the physicist and the physiologist or neurologist. He seemed to me remarkably gifted in the ability to bring to perfection such apparatus as the X-Ray equipment, the electrocardiogram and electrical apparatus for treatment and research. Quite recently he had perfected an ophthalmoscope with photographic arrangements for photographing the retina of the eye. His photographs are about four cm. in diameter and extremely clear. With these he is easily able to trace the progress of treatment in the cases of retinal tumors and other disturbances.

His string galvanometer equipment is original and extremely fine. He does not mount his galvanometer on a stone pillar but simply on a heavy wooden table. . . . He has an ammeter constantly in series with the coils of the galvanometer so that he may at all times know and regulate the field strength of the current which he is using. Through a small accessory telescope mounted between the field coils of a strong galvanometer he can view by eye the string, noting its position in reference to the eye pieces of the telescope. Thus he avoids bumping the telescope against the string and so damaging it. . . . According to the magnetization curves which Salomonson had, his instrument is the most sensitive that has ever been built. He thought it also very practical in reference to the manipulating in mounting the string and in adjusting the telescopes.

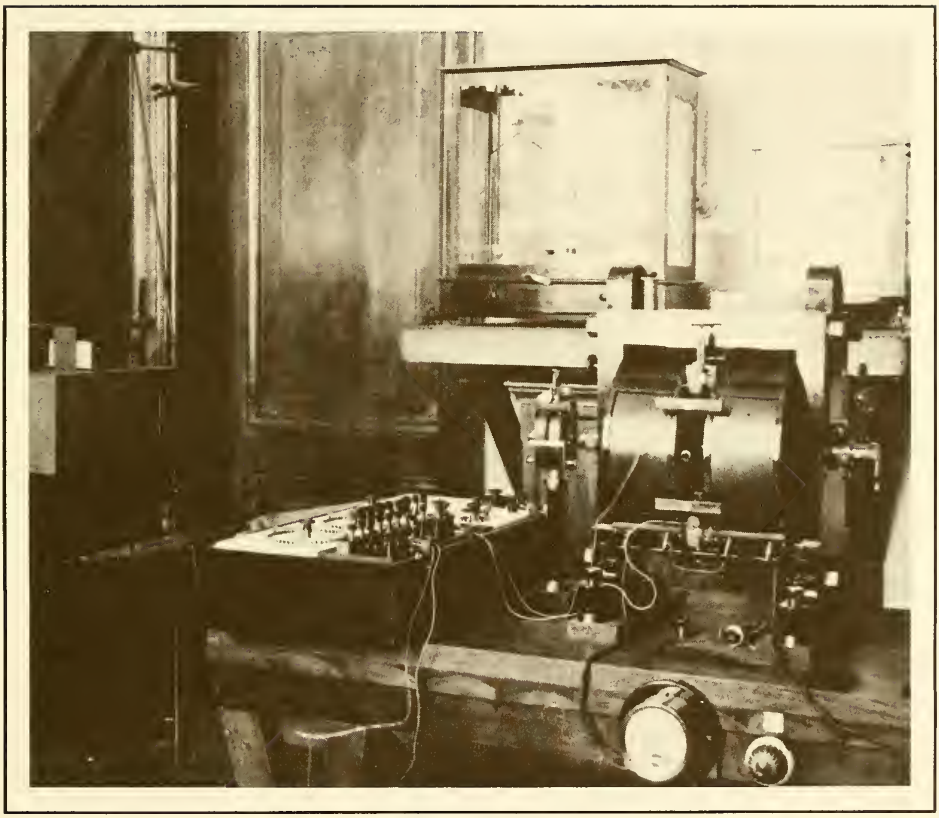
Lately he has perfected a small double string galvanometer which can be used as signal apparatus in combination with the large string galvanometer and in the same path of light projection. This signal galvanometer is shown in both views at the left of the large galvanometer. Recently, he visited the

Cambridge and Paul Scientific Instrument Company in Cambridge, England, and arranged for the manufacture of this signal galvanometer by them. . . . This small signal galvanometer is electro-magnetic and quite rugged in construction. I think it likely the most practical instrument of this sort which has yet been designed.

At the extreme left . . . may be seen the front of Salomonson's falling-plate camera. A small hood which projects from the face of the camera makes it possible to use it in the room with normal daylight. The camera is not new. It has been fully described in the literature.

On the right hand side . . . may be seen the episcotister of Hill, made in Lund, Sweden. This is the regular electro-magnetic gear drive of the Blix-Sandstromkymograph. Every gear shaft of the gear arrangement has been extended so that the spoked wheel with its collars may be directly clamped on and so secure the variety of speed. I cannot say just why this was done rather than using the gear shifting arrangement commonly supplied with the kymograph. Salomonson reported that this episcotister, when used as supplied by Hill in close proximity with the strong galvanometer, caused deflections of the galvanometer string due to the breaking and making of the circuit in the electric centrifugal regulator of the kymograph. Hence he has put on a different sort of a centrifugal governor and he made one of a friction tape. He finds that this regulates the speed of the kymograph admirably and his speed may be relied upon. He also is freed from the induced makes and breaks which otherwise occur. For my own part I do not see any advantage in this kind of an episcotister over the usual form, which employs a tuning fork to make and break the current to operate a synchronous motor.

In Salomonson's laboratory the strings for the galvanometer are prepared from Wollaston wire in which a platinum core of the desired diameter has been drawn. The original Wollaston wire is cut in the desired length and soldered to the pins which are to be mounted in the string galvanometer. The holder in which the soldering has been done is [on] the nature of a hinge so that when the wire has been properly soldered to the pins, the holder may be doubled to some extent so that the wire will loop down into a vessel containing the nitric acid for etching off the outer coatings of the wire. Thus the wire is immersed in the nitric acid to points very close to the ends which have been soldered to the two pins. The manipulation is thus very simple and when the etching process is complete, the wire is withdrawn from the acid, the holder is straightened out, and from this holder, the string is mounted directly into the galvanometer. This technique avoids all soldering and extra manipulation after the string has been reduced to the desired size. It is very easy to solder and otherwise



Professor Salomonson's electrocardiagraphic outfit of his own design. (Photo courtesy of Yale Medical Historical Library.)

manipulate the Wollaston wire and if the attempt at etching is a failure, i.e., if the wire breaks, there is not much loss of time. Salomonson thought it was not necessary to have such a splendid string as those manufactured by Williams and used commonly in his instrument in the United States.

In the case of Salomonson's galvanometer the optical system is adjusted to the string after the string has been centered just as in the case of the galvanometer of Williams. Both the front and back telescopes of the optical system are orientated by operating against two screws and a spring in place of by three screws as in the Williams instrument. This makes movement much more easily produced than in the case of the latter instrument, where one screw must always be loosened before another can be tightened and one has to keep alternating between loosening and tightening of different screws until he gets the telescope where he wants it.

When not in use, Salmonson kept his instruments covered up by heavy paste board boxes which had been especially made for the purpose. This protected them from dust and avoided any part being inadvertently bumped except by the experimenter himself when putting on or taking off the cover. His largest string galvanometer is quite a heavy instrument. He has in operation two complete outfits. The second one which employs a smaller galvanometer can be partly seen in the photograph behind Salomonson. . . .

Salomonson showed me a large amount of apparatus which he had designed and had in use for measuring the sensitivity of nerve and muscles to electric shock. He could perform these measurements by three methods; induction shock; capacity discharges or direct current stimulation, and he was interested mathematically to develop a formula which would harmonize the results obtained with all three methods. I sincerely regretted my inability to follow his splendid mathematical reasoning on this problem. He has a research student who is writing his thesis on this subject and Salomonson will himself probably later get out a book on it. Although I was with Salomonson for parts of two days, I felt that I had had only the merest glimpse of him and of his many excellent instruments and techniques.

University of Copenhagen, Laboratory for Animal Physiology

PROFESSOR KROGH

I found Professor Krogh and Dr. Marie Krogh, his wife, busily engaged in the laboratory. Their immediate task was reading the proof of a large article shortly to appear in the Journal of Biochemistry on the subject of "The Relative Efficiency for Muscular Work of Carbohydrate and Fat Diets." This research was done in collaboration with three others and impressed me as a very fine piece of work. I went over a good deal of the proof. They found that [a] carbohydrate diet was more efficient for muscular work by an amount on the average of about 10%. [Here] is a photograph showing the respiration chamber which they employed in this research together with [a] bicycle ergometer. The ergometer was placed, of course, in the chamber which upon the subject's entering is tilted up as shown in the photograph. The upper movable part fits into a water seal during the experiment. The chamber is fitted with a number of windows and seemed of suitable size for bicycle work. Krogh strongly favors the method of using a chamber and supplementing this with gas analysis. He said that invariably in his own work, the use of a mouth piece or a mask disturbs the result making the respiration somewhat abnormal.

Krogh hopes to continue the research on muscular work, next time investigating the efficiency of alcohol as food for work. He expects to use the technique of Widmark of Lund to determine the amounts of alcohol in blood and urine. He referred to several papers of Widmark and spoke highly of him, urging me to visit him on the way to Stockholm. Krogh thinks that by feeding such foods as to keep the respiratory quotient high and then giving alcohol, he can tell more what happened than if the respiratory quotient is low. But he is very much afraid that small traces of the alcohol in the gases will destroy the accuracy of the gas analysis. He has made no preliminary experiments along this line up to the present.

I noticed that Krogh prepared his own figures and illustrations for publication except the drawings of apparatus. He has had difficulty with the engraver, who insists that the curves must be drawn on plain paper rather than on ruled paper. [He] complains that the ruling always shows, no matter if the lines are blue, hence Krogh draws his curves on ruled paper and then taking a plain sheet of paper, traces over and makes his illustrations to send to the engraver. It seemed unnecessary to me.

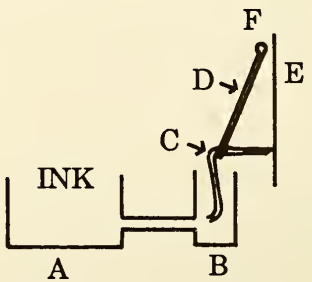
On the point raised by L. Hill that the metabolism was higher when measured out-of-doors, Krogh does not think it can be. He says, "What would cause it?" He does not see why the French should at present desire to build a calorimeter. He thinks only in cases where the respiratory quotient is about 100 and a very few other points should remain to be checked up by the calorimeter as against indirect calorimetry.

I saw something of the work which Krogh had been doing on the capillary circulation of blood. The photograph . . . was taken in his laboratory, where he was studying the capillary circulation. He had been demonstrating certain features of this research to me. He had approached the subject sometime ago by reasoning that during muscular work there must be new paths opened for the blood in order that it should absorb more oxygen, hence he began studying the capillaries and their action to see if this was the probable mechanism by which the greater absorption of oxygen was accomplished. He thinks the capillaries are innervated by two sets of nerves. A light scratch or touch on a capillary will serve as a stimulus for it to open but a strong prick or pressure contract it. The blood supply is itself the stimulus to contraction so that the open paths keep changing and thus in turn all the capillary paths get open and get their blood supply. Dale has discovered a substance which will act as a stimulus to open the capillaries but none has yet found anything that will close them. They seem to work independent of arteries. They can be seen and studied at the base of the fingernail if the skin is prepared with a drop of oil and one uses a microscope magnifying about 50 times. He has been trying to arrange a method for photographing the capillary circulation in the web of a frog. (I was able at the time of the Congress in Paris to introduce him to Dr. Bull, who gave him some assistance in reference to the technique for making these photographs.) Krogh was much interested in the subject of skin temperature, especially in connection with capillary circulation. He has no laboratory assistant except his mechanician and expects to continue his research on the capillary circulation for about two years. This work he can do by himself and needs no assistance for carrying it on. It, therefore, seems to him a favorable time just now to pursue this line of investigation. . . .

Professor August Krogh in his laboratory studying the capillary circulation of the blood, Copenhagen. (Photo courtesy of Yale Medical Historical Society.)

On my second day with Krogh, I saw the automatic gas analysis apparatus which he and his mechanician had been developing during the last year or two. This is for use in measuring the carbon-dioxide from factory furnace flues and in other such places. At the time of my visit Krogh seemed especially interested in the possibility of using this apparatus in mines to analyze mine gases and so automatically keep them below the explosive percentage. He was going to visit England very shortly and one of the reasons was to see Haldane and discuss this problem with him. The apparatus is mounted on the side of the wall and needs only a small pipe with running water. It is the flow of water which operates it, causing it to draw in a sample of 100 c.c. of the flue of gas. It gradually passes this sample through the potash into a small spirometer of Krogh's usual type. (See the very small spirometer . . ., at the right hand side of the photograph. This one shown is for collecting the expired air of insects. The one used on automatic gas analysis apparatus is about twice the size of this one in the photograph.) As the movable part of the spirometer rises, it picks up a counterbalanced arm when the spirometer has in it 80 c.c. The arm carries a writing point and starting at 80, is moved vertically along a narrow drum carrying a rather long length of paper. The amount by which the writing point falls short of reaching the 100 c.c. level shows the amount in percent of carbon-dioxide in the flue gas. The apparatus is accurate to one-tenth of one percent. After the sample has all been driven through and analyzed, the level of the water continues to rise and finally operates a syphon, causing the sampling tube to be emptied as well as the spirometer. Then another sample is drawn and gradually passed into the potash and so on. Each time the drum is turned around, a small instrument allows a new line to be drawn by the pen. The apparatus makes an analysis each three minutes and is very regular in its operation. The pen which is employed is original and, I thought, of especially practical design. It is shown in the accompanying diagram.

Diagram of Krogh's Pen



The ink as needed passes from the larger receptacle A into B. The capillary C, except when moving upward and even for a part of that time, is in the ink and keeps in good condition. The capillary tube is carried by the small arm D. It is held in contact with the drum E by its own weight and tendency to swing down on the axis F. Even at its lowest point, the capillary is in contact with the paper of the drum. I asked Krogh, "Is the pen original?" He answered, "I think so." It is quite typical of Krogh that he should not have said flatly "Yes," in answer to my question. He impressed me as one of the most careful men concerning the statements which he makes. He does not effervesce or demonstrate much enthusiasm either about his own work or the work of other people. He is the perfect embodiment of the quiet, humble, but keen, indefatigable scientific worker. In conversation and the demonstration of apparatus, he has continually to be drawn out. He never tells you more or demonstrates further than you ask for, not but what he is quite willing to tell or show what he has, it seems to be the make-up of his disposition.

In reference to the automatic gas analysis apparatus, they have taken out a patent in the United States, among other countries, and have perfected the apparatus not only for carbon-dioxide but also for carbon monoxide. They figure, I believe, that the complete apparatus will cost about 700 crowns. It has quite a commercial field. The other arrangement now used for a similar purpose have many points of dissatisfaction. The matter is, of course, of much economic importance in factory management. If a fireman uses his boiler so the flue gases show only 5% of carbon-dioxide, he is losing 30% of the fuel value of his coal. The best results that can be gotten are when the flue gasses show 14 or 15% of carbon-dioxide.

Krogh showed me his spirometers of various sizes. Two of these are shown. . . . A, is one liter and B about 10 c.c. for use with small insects. He said in general this type of spirometer when in working condition will rise and fall, i.e., follow 60 pulsations of air per second. This means that it is very sensitive. He has a large type of cylindrically shaped spirometer built into one corner of the room which he uses in connection with his muscular workchamber and also for standardizing wet and dry meters. It is arranged with an electrical release and has a graphic recording. The counterbalancing is very simple with small weights.

I was quite interested in a very simple kymograph which Krogh has arranged to be operated with a common cheap clockwork. . . . The shaft of the clock on which the main spring exerts a torsion extends a short distance from one side of the works and fits into a receptacle on the end of the shaft which supports the kymograph. When the clockwork is allowed to run, the whole

works revolve on this pivot. Some small projections which can be seen on the lower side of the works . . . engage with the kymograph drum which turns freely on the shaft and causes the drum to be revolved. The speed is changed by the fans shown in the photograph. The fans are tilted at different angles and so their effected resistance is changed without changing the different pairs of fans. A wide range of speed is attained with this simple kymograph which I think would be relatively cheap and an excellent apparatus to use in teaching or for much experimental work. One base . . . serves for the kymograph support and the support for the registering apparatus; thus everything can be moved together very simply. An extension from the base of the larger spirometer A provides a support for one of the simple kymographs in connection with the spirometer.

Anyone interested in the physiology [of] respiration is certain to be well repaid for his efforts to visit Krogh. He can secure from him a great deal of information which one feels is very straight forward and given without bias.

Karolinska Institute of Stockholm, Physiological Laboratory

PROFESSOR JOHANSSON

The circumstances of war which naturally produced many problems for neutral nations have so shaped conditions that Professor Johansson has been as busy as ever with commissions and boards and hence the amount of experimental work which he has done in recent years is practically nil. He is a very charming personality and, of course, well fitted for work which brings him into contact with public officials. A satisfactory photo of Johannsson at his desk is shown. . . .

Since the visit of Dr. Benedict in 1913, they had constructed a new respiration chamber in the depression made in the floor in the basement room where was located the respiration chamber which Dr. Benedict speaks of . . . which was modeled after the bed calorimeter in the Nutrition Laboratory. This new chamber is made of sheet metal and so arranged that the upper part can be raised to allow the subject to get in and out. . . .

The Johannsson Ergometer has also been constructed within recent years. . . . It is arranged so that both positive and negative work may be accomplished independently. I thought, however, the working position was not particularly favorable. If one leans against the table with the chest, although the table is shaped for the body, still there is apt to be some hampering of the respiration and one cannot easily divorce the work with arm muscles and back muscles. . . . The cover of the chamber when lowered goes into a water seal as can be seen at the lower part. . . . The approximate size of the chamber may be guessed from these views which show both mechanician Yarl and Professor Johansson inside of it. The chamber is barely large enough for using the bicycle ergometer. The equipment for research here is very satisfactory and it is regrettable that it is not being used more nearly up to capacity.

Johansson's Laboratory was in splendid order. He has much ability and interest in having a place for everything. The instrument cases are very numerous and contain great quantities of smaller types of physiological apparatus. There are many things of an historical value and a careful catalogue and description of these things is in preparation. He had continued his accumulation of lantern slides made from original sources. These he uses very largely in his teaching work, and I imagine, with very good results. His niece, Miss Brita Johansson, is his secretary and photographer.

One of the especially pleasant features of a visit to Stockholm is the opportunity of seeing Professor Arrhenius, Director of the Scientific Academy of the Nobel Institute and worker in Physical Chemistry. Professor Cohen of Utrecht had been kind enough to suggest giving a card of introduction to Professor Arrhenius. I had no need of this card, however, being in company with Johansson and although Arrhenius was strenuously employed at the time of my visit in looking after the American and Swedish singers who were then in Stockholm, he found time to come to the home of Johansson for dinner one evening. . . . It was delightful to find how interested he was in the Nutrition Laboratory and in American Science in general. His genial conversation quite captivated me. I had a little unexpressed wish that before long he would turn his mathematical skill to some consideration of the effects of alcohol.

The Johansson ergometer is inside a respiration chamber, special accommodation for which has been made in the floor of the laboratory. (Photo courtesy of Yale Medical Historical Library.)

Professor Siegfried Garten at his desk in the Physiological Institute, University of Leipzig. (Photo courtesy of Yale Medical Historical Society.)

University of Leipzig, Physiological Institute

PROFESSOR GARTEN

For me it was of very great interest to visit this Laboratory, which has been made famous through the directorship of Ludwig and Hering. Professor Garten, who has lately come into this position as director of this Physiological Institute of Leipzig, was very cordial. He thanked me several times for coming to see him, saying that they felt very much cut off from the scientific world. Nothing was said in our conversation about the war or the Physiological meeting in Paris or that which occurred in Hamburg, but he told me seemingly with the greatest freedom of the researches on which he had been engaged during the war. These had concerned problems in reference to aviation and the selection of aviators. He had developed an apparatus for more or less imitating the conditions of controlling the aeroplane. The subject was seated in a chair which might be revolved forward or backward or sideways or in any axis whatever about a pivotal point which was a little below the seat. He was tilted and then by a stick control he tried to rectify his position and bring himself back exactly to the first position. The error of his compensation was read in degrees by the experimenter. He put me in the apparatus and made several tests with me. The apparatus is figured and described in a reprint which he supplied. . . . I was pleasantly surprised at his seeming willingness to show me anything he had. In the lecture room, they had put up a long swing coming down at the end of the lecture desk and by this arrangement they could quickly test the nystagmus time. The two ropes of this swing were twisted around a certain number of times and in this way a given number of turns could be supplied to the subject and in about a given time. They could also combine the turning with other movements if they desired.

Garten, as is well known, is particularly interested in string galvanometer technique and electro-physiology. He had a very well equipped room devoted to

this subject. The room looked like a place in which a very large amount of work had been done. Its equipment seemed exceedingly practical. He had a film camera something like the Frank kymograph. Of this he had several of the same model and used it in connection with all his string galvamometer equipment. His string galvanometers were all of the Edelmann type. For vibrating time marker [sic] and to secure a wide aptitude of vibration he used a tuned reed mounted in a pipe and the air was drawn through this pipe by a small pump attached to the faucet. The reed was therefore caused to vibrate before the slit of the camera much like an organ reed. He said he thought the device was original with himself but later found that someone else had made just such a thing. . . .

Professor Herring, the previous director of this laboratory, was particularly interested in the problems of light and vision. There was much demonstration apparatus for this field of work and a particularly large and complicated spectroscope for providing light of different wave length for experimental purposes. In a dark room Professor Herring had arranged a small window so that it might be covered with glasses of different color and the sunlight, passing through these screens [and] falling on different backgrounds, provided quite wonderful contrast effect, the most beautiful teaching arrangement of this character that I ever saw.

In Garten's office I saw a copy of the United States Government Publication entitled "Air Service Medical." Garten pointed this out to me, saying that he knew something of the work in reference to aviation that has been done in the United States. It seems that this book came to him through someone of the neutral countries. He was pleased that I desired to take a photograph of him at his desk in his office. I regret that I had only a vest pocket camera with me at this time. . . .

University of Vienna, University Hospital Kinderklinik

PROFESSOR VON PIRQUET AND DR. SCHICK

In visiting Vienna, I had hoped to see Professor Exner and also Professor Durig. It so happened that the former, who has retired, is living in the country quite a distance from the city, and the latter had, on the day of my arrival, sent his family away on their vacation and was himself following on the next day. My friend, Mr. Roger Clark, at the head of the Quaker Mission in Vienna, saw Professor Durig at the railroad station and told him of my presence and my desire to see him. He begged to be excused on account of his poor health and the fact that he was just leaving the city and said that he was leaving a small book for me which he had lately written.

I visited Dr. Van Pirquet at his home and also at the Hospital at [sic] Kinderklinik. On the second day of my visit to the Hospital, which visit began quite early in the morning, I had also the company of Dr. Alfred F. Hess of New York. Von Pirquet has recently devised and put forward a new terminology in reference to nutrition. He has two methods for testing under nourishment in people. Naturally the subject of under nourishment is of extreme importance in Vienna at present and has been during the past few years. One could see clearly in passing down a street that the thing the people needed and the thing they were interested in was food. Under the present conditions it is impossible to feed everybody in Austria. The question arises how to sort out the people and select those most under nourished and most in need of supplementary food by relief organizations working in that city. The first method of Von Pirquet is called "Pelidisi" meaning the measurement of weight and length of body compared to the average. Von Pirquet claims that experience has taught that the following equation is correct for grown people. The weight of the individual times ten equals the cube of the sitting height in centimeters. An adult with a sitting height of 90 cm. has for instance a normal weight of 90x90x90 or 72900

grams or 72.9 kilograms. A school child does not have as much fat and muscle as the adult, so that the Pelidisi is on the average not 100 but 94.5. Children with a Pelidisi of 94 and less are considered underfed. Those with a Pelidisi of from 95 to 100 are considered well nourished and those with 101 and above as over fed. Inspectors of the American Child Welfare Mission record the sitting height and weight of all children attending school in all towns having feeding stations. The Pelidisi is then found by referring to a table and thus children selected who are to receive food. The selection is made on this basis of the state of nutrition regardless of the class or income of the patient and without the influence of religion or party political prejudices.

The second method of measurement of undernutrition is what Von Pirquet calls "Sacratama" meaning measurement of condition of blood, fatness, skin fullness and muscles. The word Sacratama is a composite word in which the consonants or constants indicating the different bodily elements or parts examined and the vowels varying indicating the condition of the different parts [sic]. Thus "Sacratama" gives in one word, according to Von Pirquet's method, the whole opinion on the state of nutrition. In accordance to this summary, the children are classified into four categories: to class A all those children belong whose state of nutrition does not contain a bad mark, that is, no O or U for instance; class 1 those children belong who have one bad mark, for instance, Socratama [sic]; SO for instance stands for reduced blood coloring of the skin, a pale skin surface; CRE for an abundance in fat; CA for a medium furgor; MU a very weak muscular system. The combination SE-CRE-TA-MU gives in one word the whole thing and that is the case of nutrition. The word Sacretama [sic] would mean a meager but otherwise normal child. Class 2 includes those children who have two bad marks, for instance. Socrotama a pale and meager child; class 3 finally includes those children with three or more bad marks, for instance, Sacrotomu [sic], a child of normal complexion but which is emaciated, poor in muscle and has a flabby skin. On the whole that Sacratama examination agrees with the Pelidisi examination. Thus the examination of all primary schools of a Vienna district gives the following result.

Pelidisi	100	99	98	97	96	95	94	93	92	91	90	89	88
Percent of Children	.36	.56	1.24	2.2	3.6	5.7	9.3	14.0	14.2	15.0	13.1	9.2	6.0

Sacratama classes	0	1	2	3
Percent of children in each	7.3	4.3	13.8	74.6

The method which they now use in selecting is first to use the Pelidisi in determining all the children of the school. Those children who show 94 or less are forthwith admitted to the feeding. The remaining children are examined as to their Sacratama and those most qualified admitted depending on the proportions of food still at their disposal. Examinations are repeated every two months and children who have regained weight about 94 Pelidisi or have improved their Sacratama are eliminated and replaced by children with bad marks in nutrition.

The feeding of Austrian children with American food is carried out under what Von Pirquet calls the "Nem System." This system takes as its unit of measurement the nourishment value of one gram of mother's milk. This basis value is called "Nem" for the initial letters of the three words Nutrition, Element, Milk. The nourishment value of 100 grams of milk is called hectonem and abbreviated Hn., of one thousand grams kilonem and abbreviated Kn., and of one thousand, tonnenem and abbreviated Tn. All food stuffs are compared in their calorific value with the milk standard. The milk standard equals 667 small assimilable calories according to Koenig, or a large assimilable calorie equals one and one-half Nem. The nourishing value of the American food stuffs according to the Nem system measure up as follows: Evaporated milk, 2 Nems for a gram; One tin contains 450 grams or 900 Nems; Sweetened Condensed milk, 5 nems and a gram, One tin contains 400 grams or 2000 Nems or 2 Kilonem; Cocoa, 6 Nems and a gram; Sugar, 6; Flour, 5; Rice, 5; Peas or beans, 4; Stock, that is lard or lard substitutes, 13 1/3 to the gram; Bacon, that is pork, 10; Canned meat, e.g., corned beef, 2 1/2 Nems in a gram. As a uniform measure for the meal of a school child, the food quantity of 1000 Nems or 1 kilonem, roughly 1 meter or one quart of milk was taken. This food quantity has a caloric value of 667 large assimilable calories or of roughly 700 large raw calories.

I do not know that it is necessary to say anything more in detail about the Von Pirquet Nem system and the way which it is carried out in the feeding of children in Vienna and also its use to some degree in feeding of adults. Von Pirquet told me that the system of animal nutrition and its nomenclature was in very much better condition than that of human nutrition and that in animal nutrition they made a unit the gram of cow's milk. He had tried to do the same thing for human nutrition. His whole system is fully given in a three-volume book now placed in the library at the Nutrition Laboratory. He has a large number of publications on this matter. I found Von Pirquet a very excellent administrator, capable of getting nurses and hospital people to carry out his instructions very satisfactorily. The kitchens which I visited where food for "Hoover Feeding" was in preparation seemed most excellent. However, I could

see no special advantage in the development of this new terminology. He thought it to be much more understandable by trained nurses and in the home of people.

Shortly before my visit in Vienna a group of German doctors who had been cooperating with the Quaker Child-Feeding Committee in Berlin, visited Vienna to observe the work of Von Pirquet. I understand that they were well impressed with his work but not with this terminology and his system.

On the roof garden of the children's clinic I saw a large number of children who were being treated for tuberculosis by the open air method. They lived practically without clothing, both summer and winter, sleeping as well as feeding and playing out-of-doors. They were as tanned as Indians and at first sight one would think they were of some colored race. The treatment appeared to be extremely successful. Von Pirquet thought it had something to do with the changed conditions in the blood due to the tanning of the skin. He did not say what part of the sun's light, whether the infra-red or the ultra-violet was the cause of the benifit [sic] from living in the sunlight.

At the Mauddling Home, I saw a large number of children reported to have rickets [and who] certainly were in a very under nourished condition, some of them extremely small for the age which they were said to have. I never saw children have better medical attendance than these. The physicians seemed to be in excellent "rapport" with the patients, who were well fed and well attended to. They were using a large amount of cod liver oil in treatment of these cases. I spoke to them of the possibility of using some mixture of beef fat to replace the cod liver oil. I had previously learned from Dr. Mallenby in England (we spoke about the matter at the Physiological meeting in Paris) that he had made the suggestion that beef fat could be mixed with glucose and peanut oil and made palatable and would be the next best thing to cod liver oil to combat rickets. About three barrels of this mixture were made up and sent down to Vienna; I believe, however, they were in the hands of Dr. Chick, who came from the Lister Institute and [who] at the time of my visit in Vienna . . . had returned to London. I could find nothing about the result from the use of this glucose and beef fat mixture which, I believe, they called "Butol." In fact, I found the physicians of Vienna with whom I spoke not especially interested in it, because they had all the cod liver oil supplied to them that they wanted to use, in spite of the fact that the English looked upon the cod liver oil as being extremely expensive and [wanted] a substitute. At this Mauddling Home, it costs 40 cents a day to maintain a bed. They had about 200 beds. The bill for keeping these going was met by subscriptions from a group of people in New York City. They had plenty of space in which to enlarge this type of work and

they had a tremendous waiting list of patients that should come in under their care, patients of practically the same class of need from under nourishment. No provision had been made for these nor was any in sight.

I had an opportunity for a short visit with Professor Paulta, formerly professor of pathology in the University of Vienna. He showed quite clearly the marks of under nutrition or at least, of weakness, which could not be charged up entirely to old age.

The streets of Vienna seemed rather empty, the city appearing too large for the population. There were many people very poorly clothed, some men bare footed and the clothing of the common professional man on close inspection showed that it was made of a combination from several suits and had probably been turned and changed one way or another more than once. I was informed on good authority that many of the middle class of professional people had found it necessary to sell things in their homes in order to provide food for their families. A competent young woman from the Laboratory of Dr. Cathcart was working in connection with the Friends Service Committee investigating the actual dietaries of a number of poor Austrian families . . . she was going to compare [these dietaries] with data of similar nature gathered some time ago in England. Such work as this will give the best indication of conditions in Vienna.

General Remarks

Prior to 1914, almost each year found one or more responsible members of the Nutrition Laboratory staff visiting foreign institutes and laboratories in which work was being conducted in the same or closely related fields of research and frequently foreigners were in collaboration here. For example, in 1913, Dr. Benedict made a very extensive trip to foreign laboratories during the months [from] February to June. In the same year, Dr. Higgins was in Europe during the months from May to December. He collaborated in the study of the effects of alcohol on fatigue with Professor Galeotti at the Monte Rosa Laboratory. He visited also several other laboratories both in England and on the Continent and attended the Physiological Congress in Groningen. During the same year, at least three Europeans spent considerable time working at the Nutrition Laboratory: Dr. Carl Tigerstedt of Helsingfors, Dr. Murschhauser of Dusseldorf and Dr. L. Bull of the Marey Institute, Paris.

I came to the laboratory in the spring of 1914 when Dodge and Benedict were finishing their joint publication on the *Psychological Effects of Alcohol* (Carnegie publication 232) and very shortly after I arrived, Professor H. M. Smith went to Europe. He had scarcely more than reached Germany when the beginning of the war made it necessary for him to leave and return to America. This cordial cooperation and association with European laboratories has been interrupted for somewhat more than six years. I count it a very great privelege [sic] to have had the opportunity of representing our laboratory by going to Europe at this particular time. . . .

My object in going to Europe was, therefore, to help to again establish a cordial relationship between foreign laboratories and ourselves; to familiarize ourselves with changes in personnel and organization and with the present activity of these laboratories, as well as making our own work known to them. Personally, it was my first opportunity to become directly acquainted with many of the workers and I was keen to discover techniques and methods in

clinical psychology with adults which might be useful at the Nutrition Laboratory, and in general I considered it a unique opportunity to have some part in re-establishing international scientific relations at a time when the world has been so scourged with a spirit of hate.

Hardly any experience can be more stimulating to the scientific interest and zeal of a man than to come into personal contact with the workers in his own field. While it is possible to associate with these men at scientific meetings and congresses, much more in net results can be gained by visiting them personally in their own laboratories and institutions. Only such occasions allow for extended discussion of problems of mutual interest with apparatus and results at hand for observation and demonstration. Under these circumstances one is able to make quite an accurate judgment as to the man's methods or work and the reliability of his results and thus to more properly evaluate his publications, both past and future. Incidentally, one discovers a good many useful details of laboratory equipment and management never shown in any way in publications.

As the previous pages show, I visited laboratories in England, France, Belgium, Holland, Denmark, Sweden, and to some extent in Germany and Austria. I attended three scientific meetings: The British Psychological Association, London; The British Physiological Association, Cambridge; and the Physiological Congress in Paris, giving papers at the two latter meetings. On June 16, in Amsterdam, I delivered an address on the work of the Nutrition Laboratory of the Carnegie Institution of Washington at the first public meeting in Holland regarding the establishment in that country of a National Institute for Nutrition. I was everywhere greeted with greatest cordiality, thus emphasizing in my own mind that the interchange of such visits is bound to result in a better international understanding.

Perhaps it does not sound well to say that on such a visit one makes it his partial aim to advertise the laboratory from which he comes. However, I believe it is the duty of a man employed by an institution such as the Carnegie Institute of Washington, which was endowed with the purpose of the "improvement of mankind," to make every reasonable effort to familiarize the world with the work and scientific results produced by this laboratory.

Unfortunately, there is in Europe the impression that an American is always wealthy and can find money for any *scientific* project that may be mentioned--e.g. the publication of some big treatise or compilation. It seemed to me a duty to make clear to the European workers that American scientists have to be economical and that the war has greatly reduced the buying power

of the incomes from all endowments left to scientific institutions; that therefore we do not at present merit the reputation which the earlier affluent days seems to have produced.

The unique importance of nutritional problems during the recent war, with the persistent shortage of food still bitterly experienced in certain parts of Europe, made it profitable for this laboratory to secure some first-hand data on present nutritional conditions in those countries, especially in the Central Powers, and to have a representative inspect to some extent the methods and work of relief organizations operating in the latter countries. It is my conviction, after seeing the conditions, that the Americans would do well to render all possible assistance to these countries at present.

I came back with the opinion that experimentation in reference to the physiological effects of alcohol is still very important for the world in general. Europe is looking upon Prohibition in the United States as more or less of an experiment, and there probably is more interest in scientific data on alcohol experimentation than ever before.

When visiting laboratories in rapid succession, one is almost staggered by the multiplicity of workers and elaborate equipments, and although many of the European laboratories are quite old, yet there are a number almost brand new and I was impressed that there are many things, both great and small, that the Americans can learn with profit from the Europeans.

--W. R. Miles
August, 1920

APPENDIX

BIOGRAPHICAL NOTES

1. LEONARD E. HILL (1866-1952) trained in medicine at University College, London, and went into physiology under the influence of Burdon Sanderson and Schafer. His early work was on measurement of the cerebral and peripheral circulation (he shared responsibility for introducing the arm cuff method of blood pressure measurement in humans in 1897). Hill was elected FRS in 1900 and knighted in 1930.

In the early years of this century Hill carried out studies of the effects of exposure to high atmospheric pressures, which contributed to methods for avoiding the "bends" by staged-decompression. This was of great significance particularly for the welfare of divers, construction workers and the military.

In 1912 Hill was the first incumbent of the Chair of Physiology at the London Hospital, and in 1914 he became Director of Applied Physiology at the National Institute for Medical Research, where Miles visited him on his trip. At the NIMR, his interest was focused on the effects of ambient temperature on humans. This interest was greatly spurred by the war, during which his studies extended to the ventilation of trenches. He devised a method for measurement of the "cooling power" of ambient temperature based on an instrument he called a "katathermometer." The cooling power depended on three factors: convection, radiation, and evaporation, and thus was an early attempt to obtain an estimate of what one today refers to as "wind-chill factor." Much of Miles' account of his visit with Hill is concerned with this instrument. (*Obituary Notices of Fellows of the Royal Society, 1952-1953)*

2. The education and career of BENJAMIN MOORE (1867-1922) covered a range of disciplines and influences. He received his bachelor's degree in engineering from Queen's College in Belfast. He then went to Leipzig to work

in the laboratory of Wilhelm Ostwald, where he trained in physical chemistry. From there he went to University College in London in order to study physiology with Sir Edward Sharpey Shafer. He then proceeded to Yale as an associate professor of physiology. Moore returned to England from New Haven to accept a position as a lecturer in physiology at the Medical School of Charing Cross Hospital, where he also earned his credentials as a medical doctor. He took the Johnston Chair of Biochemistry at the University of Liverpool in 1902. During this time he pursued varied subjects of research, including the equilibrium between the living cell and its environment, the effects of anesthetics, metal toxicity, and the effect of light and varying oxygen tensions on micro-organisms.

Moore wrote prolifically on physico-chemical aspects of the cell and contributed to the progress of biochemistry as a discipline in the first two decades of the twentieth century. In 1906 Moore founded the *Biochemistry Journal*, which he edited until 1912.

Moore moved to the National Institute for Medical Research in 1914. His book, *The Dawn of the Health Age* (1911), advocates a national medical service. During the war he conducted studies on such practical problems as T.N.T. poisoning and Miners' Phthisis. At the time of Miles' visit in 1920, his mind had turned to more speculative research on the question of the origin of life. Later in the year he was made Chair of Biochemistry at Oxford University, but died within a couple of years. ("Obituary Notice, Benjamin Moore," 1928)

3. HENRY HALLETT DALE was born in 1875, and was a scholarship student at Trinity College, Cambridge. His research training began at Cambridge under Langley and his co-workers, who were laying the foundation for the pharmacology of the autonomic nervous system. Interleaved with medical studies was further research with Starling and Bayliss in London (1902-1904), Paul Erlich in Frankfurt (1903), and Henry Wellcome (1904-1914) at the Wellcome Research Laboratories, where Dale became director. In 1914 he was appointed Director of the Department of Biochemistry and Pharmacology of the Medical Research Committee; after the war this department became the National Institute for Medical Research of the Medical Research Council, with laboratories at Hampstead, where Miles' visit took place.

In his work at the Wellcome, Dale made many fundamental discoveries. He identified the first adrenergic blocking agent (ergotoxin), in 1906, and demonstrated that posterior pituitary extract causes the uterus to contract, in 1909. From the early work came such present-day terms as

"sympathomimetic" (for drugs that simulate the action of the sympathetic nervous system), and "nicotinic" and "muscarinic" for the two main actions of acetylcholine. By 1914 he had initiated his two major contributions: characterization of the chemical messengers (neurotransmitters) at neural synapses, and mechanisms of anaphylactic shock, the latter studies summarized in his Croonian Lecture to the Royal Society in 1919. The biochemical and pharmacological nature of his work was outside Miles' main interests. Unfortunately, he did not meet Dale, and contents himself with a brief description of some kymographs. Dale received the Nobel Prize in 1936, and died in 1968. (*Biographical Memoirs of the Royal Society*, 1970; Gillispie, 1976; Williams and Nicholls, 1981)

4. JOHN BROWNLEE (1868-1927) received his education from Glasgow University, where he concentrated on the disciplines of mathematics, natural philosophy and medicine. He ultimately became an epidemiologist and made important contributions in the epidemiology of tuberculosis and measles.

Early in his career, Brownlee held the position of Officer of Health for the town of Guernsey and subsequently was made superintendent at the Belvedere Fever Hospital in Glasgow. In 1914 he was selected as the first director of the statistics department at the British Medical Research Committee. (Walton, 1986)

5. EDGAR SCHUSTER (1879-1965) was educated at New College, Oxford. He began his career in zoological research at Oxford and then in 1904 was awarded the first fellowship for research on eugenics, under Francis Galton in London. This fellowship led to a book entitled *Eugenics*, published in 1913. Meanwhile, in 1907 he had returned to New College, where for several years he studied the brain of primates, collaborating in some of this work with Sherrington (q.v.).

During the war, Schuster served in several capacities, ultimately in the Medical Research Committee, the precursor of the Medical Research Council. As noted in the diary he continued there after the war until 1930, editing the Council's reports. (The diary also gives the impression that the whole publication department was pretty much a one-man operation.) Miles indicates that he mainly focused on learning from Schuster how the new National Institute for Medical Research functioned, a matter of some relevance to the Carnegie Institution and to the future organization of American science support.

Schuster's real love and skills lay in instrumentation; in fact, Miles notes in the account of his preceding visit with Brownlee that "There were two harmonic analyzers both designed and one made entirely by Schuster. It was a beautiful piece of work" (see *Diary* excerpts, p. 13). The annual report of the Medical Research Council for 1921-1922 contains the following comment:

> It happens by a fortunate coincidence that Dr. Edgar Schuster, in charge of the Department, is highly skilled in the arts of mechanical design and construction. He has devised and executed in his spare time many pieces of scientific apparatus for use in the research work of his colleagues, and to some of these reference will be made below. The Council are greatly indebted to him for regular service, beyond his nominal duties, in advising upon the design of all mechanical apparatus constructed in the Institute for work within it or outside.

The preceding was quoted by Paton and Phillips (1973), who observe that the author of this comment was probably the director of the Institute, H. H. Dale (q.v.).

One of us (Gordon M. Shepherd) has had personal experience with Schuster: Upon beginning my doctoral research at Oxford in 1959, Phillips took me to meet him in his "finely-equipped workshop at the end of his lovely garden" (Paton and Phillips, 1973) in North Oxford. The head-holder, oscilloscope camera, and micropipette microforge used in our research was designed and built by Schuster. Paton and Phillips make a further observation which describes precisely my own interaction with Schuster, and captures the atmosphere of the earlier age and the close working relationship between the physiologists, pressing ahead with their experiments, and their instrument makers, upon whom they were so critically dependent:

> Knowing that a scientist's enthusiasm is apt to suffer if there are tedious delays, he designed his instruments so as to avoid the necessity for elaborate drawings, castings, and laborious hand-fitting, and he wasted no time on showroom finish, although his designs were always pleasing to the eye; he liked to produce, as quickly as possible, something that could be tried out under working conditions, and at this stage he expected the scientist to collaborate in the task of perfecting its performance, and was himself prepared to go to unlimited scrapping and reconstruction to achieve this end. (Paton and Phillips, 1973)

6. JOSEPH BARCROFT was born in 1872 in Northern Ireland and educated in England at King's College, Cambridge. He was a classmate of Dale (q.v.) and the physicist Rutherford. Following first class honors in physiology in 1897, he took his research training with Langley and colleagues. His early work on the submaxillary gland was the first comprehensive analysis of the changes in oxygen uptake and carbon dioxide associated with physiological activity of a body organ. This research led to a series of studies of haemoglobin and its dissociation curve for oxygen under different physiological conditions, culminating in a classic book on *The Respiratory Function of the Blood* in 1914. Much of this work was carried out in large respiratory chambers in which gaseous exchange in humans and animals could be studied under different conditions of diet, exercise and simulated high altitude. During the war Barcroft applied this knowledge to analyzing the effects of poison gas on respiratory functions.

After the war Barcroft returned to his interests in high altitude affects. For this research he built a glass-walled respiratory chamber and determined to test the theory of J. S. Haldane and Douglas (q.v.), that during acclimitization to high altitude the lungs secrete oxygen. Barcroft did the experiment on himself, spending six days in the chamber having blood drawn by direct arterial puncture, and exercising on a stationary bicycle, while the oxygen in the air was gradually replaced by nitrogen. Under these carefully controlled conditions, no evidence for oxygen secretion by the lungs was found. This is the experiment to which Miles refers.

Barcroft subsequently made fundamental contributions to understanding the physiology of the spleen and related blood-storage organs, and he carried out pioneering studies of foetal physiology up to his death in 1947. (*Obituary Notices of Fellow of the Royal Society*, 1948-1949)

7. EDGAR ADRIAN was born in 1889 in London, the son of a lawyer. Like many other British scientists of his day, he was educated at Cambridge, where he was in Trinity College, and graduated with first class honors in physiology in 1911. He then began research on the physiology of nerve fibers under Keith Lucas. Lucas was the foremost British authority on the electrical properties of nerve and muscle, having carried out a series of experiments on the "all-or-nothing" character of the impulse in the first decade of the century. Adrian extended this line of experimentation very effectively for several years. In the summer of 1914 he took up clinical studies in order to finish his medical degree, and spent the last two years of the war partly as a neurologist, finding time to carry out research on the electrical properties of denervated muscle. During the war Lucas worked on problems of aeronautical engineering, but

died in October 1916 in an accident. He left an almost completed manuscript of a monograph, which Adrian edited and completed, the book being published as *The Conduction of the Nervous Impulse* in 1917.

Adrian became a fellow at Trinity in 1919 and a university lecturer in 1920. After demobilization in the summer of 1919, he quickly assumed Lucas' mantle and began experiments on the recovery of excitability following stimulation in nerve and muscle. He was engaged in these experiments at the time of Miles' visit.

Lucas had been renowned for his ingenuity in designing experimental apparatus, as is evident in Miles' account. The pendulum contact breaker was a large mechanical device with a sliding arm which enabled one to deliver paired shocks at precisely timed intervals, as was necessary for investigating recovery processes. The contact breaking device is mentioned by Miles appears to have been reported by Adrian at a meeting of the Physiological Society ("A rotating contact breaker designed by Keith Lucas," *J. Physiol. Lond. 54*, 26P). (*Biographical Memoirs of Fellows of the Royal Society*, 1979)

8. CHARLES S. SHERRINGTON was born in 1857 and educated at Gonville and Caius College, Cambridge, where he began research in physiology under Michael Foster. He worked mainly with Langley and Gaskell, who played important roles in training a generation of British physiologists and pharmacologists, among them Dale (q.v.), Barcroft (q.v.) and Adrian (q.v.).

In 1906 Sherrington published his *Integrative Action of the Nervous System*, summarizing twenty year's work on spinal reflexes and establishing himself as the leading authority on the functional organization of the nervous system. From 1895 to 1912 he was a professor of physiology at Liverpool, and came to Oxford as Waynflete Professor of Physiology in 1913, at the age of 56.

During the war he turned his attention to practical problems for the Industrial Fatigue Research Board, serving not only as chairman but also working for a time as an unskilled laborer in a munitions factory in order to obtain first-hand knowledge of problems of industrial fatigue. He also was involved with the Liquor Control Board, and assisted in the writing of a book entitled *Alcohol: Its Action on the Human Organism*. His continuing interest in this area is noted by Miles.

The war had delayed the setting up of Sherrington's laboratory at Oxford, and he returned to this task with some urgency in 1919. A step forward was

the use of the isometric myograph together with optical recording for measuring muscle tension with greater precision. The movements of the myograph were registered by tracings on a smoked drum, called a kymograph, the traditional means of recording physiological results from the middle of the nineteenth century until the 1950s. Technical improvements in kymographs were therefore of great interest, and Miles makes special note of Sherrington's attempts to obtain rectilinear tracings from the rotary movements of the lever arm. He also comments on the ability of the revolving drum to accelerate quickly from its stationary position (to conserve paper) and maintain a constant speed (to ensure accuracy). This type of equipment enabled Sherrington to carry out, with a number of distinguished students, a brilliant series of experiments during the 1920s on the excitatory and inhibitory properties of spinal reflexes that led to the Nobel Prize in 1932, shared with Adrian (q.v.).

Sherrington's gentle disposition and friendly, open manner made him universally loved, as is evident in Miles' concluding comment. The lisp and hesitation in speech are of interest, in that they are not noted in the official biographies. (Gillispie, 1976; *Obituary Notices of Fellows of the Royal Society*, 1952-1953; Williams and Palmer, 1981)

9. HENRY C. BAZETT was born in England in 1885. He obtained his university education at Wadham College, Oxford, and his clinical training in London; in 1912-1913 he spent a year as a Radcliffe Travelling Fellow at Harvard. Miles mentions that he worked with a Dr. Porter there. Bazett served as a medical officer during the war and saw considerable action in France. After the war he was appointed lecturer in clinical pathology at Oxford and a fellow of Magdalen College, also Sherrington's college as Waynflete professor. Under Sherrington (q.v.), and in collaboration with Wilder Penfield, Bazett carried out a study of decerebrate animals under chronic conditions, published in *Brain* in 1922; it is not clear whether he had started this work at the times of Miles' visit. It is apparent from Miles' account that Bazett's interests were developing in the direction of analyzing brain physiological mechanisms in human subjects, to Miles' obvious delight. In 1921 Bazett moved to the University of Pennsylvania as professor of physiology, and made important contributions to studies of circulation, temperature regulation and cardiovascular physiology. He died in 1950. (Garraty and James, 1974)

10. CLAUDE G. DOUGLAS (1882-1963) was educated at Magdalen College, Oxford, obtaining a first class degree in physiology in 1904. After medical training in London, he returned to Oxford to engage in a series of

studies with J. S. Haldane in respiratory physiology, which greatly advanced that subject. This work included two celebrated expeditions to Teneriffe (1910) and Pike's Peak (1911) to carry out experiments on the effects of high altitude on oxygen and carbon dioxide regulation. Their hypothesis that hypoxia induced secretion of oxygen by the pulmonary alveoli induced lively debate; it was opposed by Barcroft (q.v.) and Krogh (q.v.), and ultimately disproved.

At the outset of the war, Douglas volunteered for medical service, and was posted to the front in France. When Germany initiated gas warfare in April 1915, Douglas was immediately called in to study the effects of gas on respiratory function and find the best ways to combat them. He led this effort for the rest of the war with great energy, skill and heroism, and continued as an advisor to the military on these problems during the 1920s and beyond. His wartime activities brought him into frequent touch with his old friend Barcroft, who was working on similar problems.

When Douglas returned to Oxford after the war, Haldane had left, and he was inundated with teaching and other responsibilities. This activity, combined with lack of funds, greatly reduced his research activities. Miles is quick to note that the laboratory contained no new equipment, other than the large respiration chamber. Douglas continued experimenting on respiratory problems at the Oxford laboratory until his death from a traffic accident at the age of 81. (*Biographical Memoirs of Fellows of the Royal Society*, 1964; Williams and Nicholls, 1981)

11. LUCIEN BULL (1876-1972) was born in Dublin to British and French parents. He attended school in his birthplace until a visit to France when he was eighteen years old. He eventually remained in France and became a citizen of that country in 1931.

Bull became the assistant of physiologist Étienne Jules Marey at the Marey Institute in Paris. Through this association, Bull made important contributions in pioneering cinematographical methods and devices which were used for such purposes as motion picture filming and animal movement studies. In 1902 high-speed filming techniques enabled him to record 500 frames per second; two years later he increased the speed to 1200 frames per second.

During the war, Bull's research led to the invention of an apparatus used in sound ranging, a technique applied by the Allies to locate the exact spot where gunfire was generated. He devised an instrument which combined photography and recording in 1915. This instrument was tested first by the

French; later, a refined version of the apparatus was employed by the British Army on the front with much success.

Bull's other achievements in his interdisciplinary career included the development of the electro-cardiogram in 1908, and studies on optical illusions and acoustics. At the time of Miles' visit to the Marey Institute, Bull was involved with the application of electrical sparks in the high-speed filming of projectiles. (Boylan, 1978; Mertz, 1973)

12. ADRIAAN KAREL M. NOYONS (1878-1941) spent much of his life in Utrecht, in the central Netherlands. He began his association with the university there as a student and became the assistant of physiologist Hendrik Zwaardemaker, an authority on the sense of smell.

In 1912 Noyons was named to the chair of physiology at the University of Louvain where he taught for fifteen years. He set up a new institute of experimental physiology and trained a number of important students there. During this period, he carried out significant research on metabolism and the physiology of the heart. He was engaged in this work at the time of Miles' visit.

Noyons returned to his birthplace in 1927, when he was named as successor to his mentor, Zwaardemaker. He undertook the construction and organization of a new Institute of Physiology, where he expanded his research on metabolism and carried out a number of studies on the physiology of the circulation of the blood, particularly the physiology of the cerebral circulation. Noyons was a founder of the Dutch Society of Physiology and Pharmacology. (Heymans, 1941)

13. JOHANNES (KAREL AUGUST WERTHEIM) SALOMONSON (1864-1922) received his medical training in Leiden, where he earned his degree in 1888. After graduation Salomonson set up his medical practice in Amsterdam, where he began to assist in neurology. From 1893 until his death, Salomonson was an instructor at Amsterdam University. His twenty-nine years at the university commenced with a position of lecturer. In 1899 Salomonson became a professor specializing in nervous diseases; in 1915 he was promoted to a full professor in neurology and roentgenology. Through the years Salomonson's main expertise was focused on X- rays, electrotherapy and peripheral nervous diseases. Miles was obviously delighted in discovering Salomonson's gifts for equipment design. Salomonson authored a textbook on the latter subject in 1911. (Lindeboom, 1984)

14. AUGUST KROGH (1874-1949) was born in Jutland, Denmark, and was educated at the University of Copenhagen, receiving his doctorate in zoology in 1903 under Christian Bohr, a well-known respiratory physiologist (and father of physicist Niels Bohr). From the start, Krogh combined basic laboratory research with field studies of animal physiology and clinical studies of humans. Between 1903 and 1910 he carried out a series of definitive studies in gas exchange, concluding that "absorption of oxygen and elimination of carbon dioxide in the lungs takes place by diffusion and by diffusion alone." Though at odds with his mentor and with Haldane and Douglas (q.v.), this conclusion was supported by Barcroft (q.v.) and became the accepted view.

Krogh then turned his attention to the question of the transport of oxygen from capillaries to muscle cells. Combining mathematical analysis of diffusion with direct microscopic observation, he showed that many capillaries are normally closed at rest and open during exercise, due to nervous and hormonal control, thereby allowing more oxygen to diffuse into the active cells. These studies, published during the 'teens, were immediate classics, and led to the award of the Nobel Prize in 1920. A special interest thus attaches to Miles' visit, in that it provides a candid view of Krogh only a few months before the announcement of the award. Miles notes, for example, that Krogh worked alone, with no assistance other than the machinist. It was characteristic, however, that Krogh's wife, Marie, should be in the laboratory with him at the time of Miles' visit. She herself was an outstanding scientist who, though she published separately, assisted her husband in many ways.

In 1910 Krogh had moved into new laboratory space in Ny Vestergade in Copenhagen. Snorrason recorded this description of Krogh's workspace: "It was simply equipped, so Krogh set up a laboratory in his official residence and lived in the small rooms of the top story. Here he developed his many instruments for evaluating the function of blood flow and respiration: the rocker spirometer, the electromagnetic bicycle ergometer, and a gas analysis apparatus accurate to 0.001 percent". This site presumably was where Miles' visit took place; all of these instruments were described in the diary. It is clear from the diary that Miles and Krogh shared an interest in instrument design.

In 1928 Krogh moved to new space, funded by the Rockefeller Foundation, in Juliane Mariesvei. That laboratory was superseded when all medical science departments of the University of Copenhagen moved to their present space in the buildings of the Panum Institute in 1978. (Gillispie, 1976; *Obituary Notices of Fellows of the Royal Society*, 1950-1951)

15. JOHAN ERIK JOHANSSON (1862-1938) received his first degree in Uppsala in 1890 and then earned an advanced degree in Stockholm the next year. He trained for a short time in the laboratory of the great physiologist, Carl Friedlich Ludwig (1816-95). In 1901 Johansson was granted a professorship in physiology in Stockholm. His most important work was concentrated in the areas of the physiology of circulation, metabolism, and energy systems, as well as statistics associated with tuberculosis and venereal disease. Miles notes that by 1920 his actual participation in experiments had been replaced by "commissions and boards." Amongst his writings are works on the chemistry of respiration (1909), energy metabolism (1910), infant mortality in Sweden (1912), and physiological chemistry (1925). (Fischer, 1932)

16. SIEGFRIED (ERNEST HEINRICH) GARTEN (1871-1923) received his medical education in Leipzig and spent most of his life there. The exceptions were a short period in Naples to study zoology, and some years in Giessen (1909-1916) as a professor. Under the direction of Carl Ludwig, Garten originated and improved various electrical measuring apparatus.

After Ludwig's death in 1895, Garten became interested in Hering's work in sensory physiology. In fact, his association with Hering lasted for decades, first as his student in Leipzig, then as his assistant from 1899 to 1908, and finally as his successor at the University of Leipzig in 1916. Collaborating with Hering, Garten helped to create the basis for sensory physiology through his research in physiological optics and acoustics. He also contributed to the investigation of the central nervous system by electrophysiological measurements of nerve cells and plants.

Garten's innovative methods were widely recognized, as Miles makes clear. The success of his techniques and instruments put him at the forefront of the application of objective measurements in the realm of nerve and sensory physiology. (Debus, 1968; *Neue Deutsche Biographie*, 1964)

17. CLEMENS VON PIRQUET (1874-1929) was born of an aristocratic family in Hirschstetten, Austria, near Vienna. His early education took place in the home and at Catholic schools. At the age of eighteen von Pirquet went to the University of Innsbruck in order to study theology. After two years, he proceeded to the University of Louvain in Belgium, where he pursued an advanced degree in philosophy, which he received in 1894.

In 1900 Pirquet went on to earn his M.D. from the University of Graz. For the following two years, he interned at the Universitäts Kinderklinik under

the guidance of Theodor Escherich, who was then the director of the institution. Escherich studied bacterial flora in infants and discovered *Escherichia coli*. In 1903 Pirquet worked as a clinical assistant at the Kinderklinik, where he remained for the next seven years. In 1912 he became the director of the Kinderklinik after teaching pediatrics at the universities in Vienna and Breslau; he also had a teaching stint at The Johns Hopkins University in 1908.

Pirquet's early investigations concerned bacteriology and immunology. He originated the word "allergy." He was also interested in tuberculosis and in 1907 invented the TB skin test. The deprivation of the war turned his research towards nutritional problems. In pursuing this work he created a mathematical system of determining a proper dietary regimen according to the caloric needs of an individual. After the war Pirquet was appointed to Herbert Hoover's American Relief Administration in order to help alleviate the rampant starvation in post-war Austria by practicing the principles of this system.

Less than a decade after Miles met with Pirquet in Vienna, the pediatrician unexpectedly and tragically took his own life by the ingestion of cyanide. (Debus, 1968; Wagner, 1968; Rapaport, 1973)

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THE U.S. ARMY MEDICAL MUSEUM

By Thomas O. McMasters

A soldier is wounded on the battlefield. What happens in the following hour is a matter of life and limb. Much of what we now know about the treatment of traumatic injury and shock has come from just such a situation. For soldiers in the United States Army, it means that the resources of a worldwide organization comprised of over 140,000 people are brought to bear for their benefit. That organization is the Army Medical Department, dedicated to health care for soldiers and their dependents to "conserve the fighting strength."

The mission of the U.S. Army Medical Museum is to tell the story of the Army Medical Department from its inception on July 27, 1775, to the present. It would be quite enough for any history museum today to attempt the collection, preservation and interpretation of objects relating to the development of the Army Medical Department, or of medical science over the past 200 years. Our mandate is to do both. As a relatively young institution with a small collections base, we have taken the approach of displaying the organizational history of the Army Medical Department in chronological order, illustrated by uniforms, equipment, graphics and text. The museum does not attempt a clinical or anatomical history of medicine for reasons apparent below.

The history of the medical soldier in the United States dates from the very origins of our country. The Continental Congress established a medical service for an Army of 20,000 men by creating a hospital department. As in all armies of the period, disease and camp life killed more men than enemy action. An important step in controlling disease was taken when General Washington ordered inoculation for smallpox in the Continental Army. This first such Army-wide treatment greatly reduced the incidence of smallpox which had been a major threat for the first two years of the Revolutionary War.

In 1818 Congress reorganized the staff departments of the Army, creating the Army Medical Department with the office of Surgeon General, a designation which has continued to the present. From 1818 to 1890 Army surgeons were ordered to keep meterological records and investigate the relationship of disease to weather. "Meteorological Registers" published by the Office of the Surgeon General led directly to the establishment of the U.S. Weather Bureau in 1890. Many of the first meaningful statistics in public health were collected by the Army Medical Department.

Gallery of the U.S. Army Medical Museum in the basement quarters it occupied from 1946 until 1989. (Photo courtesy of the U.S. Army Medical Museum.)

Probably the largest single medical advance of the nineteenth century was the development of general anesthesia. It was demonstrated for the first time in the U.S. in 1842 and was tried by Army physicians for soldiers wounded in the Mexican War (1846-48). On the basis of this early experiment, anesthesia was rejected as "too dangerous." Interestingly, the first Army-sanctioned use of ether was in 1849 to catch a malingerer. A solider's knee which was claimed to be immobile flexed readily under the influence of anesthesia. By the time of the Civil War, both ether and chloroform were widely accepted. Union records show about 80,000 operations performed under general anesthesia with a like number possible for the Confederacy.

The story of the beginnings of the U.S. Army Medical Museum is really the story of two sister institutions which have a common parent. That parent is the original Army Medical Museum, established in Washington, D.C., in the early days of the Civil War—May 21, 1862. In his Circular No. 2 of that date, William Alexander Hammond, Surgeon General of the Army, envisioned the museum in nineteenth-century terms, that is, as a study of collection of "specimens of morbid anatomy, surgical or medical, which may be regarded as valuable; together with projectiles and foreign bodies removed and such other matters as may prove of interest in the study of military medicine and surgery." Hammond was only thirty-four when he became Surgeon General, largely due to pressure by civilian "sanitary commissions," which were set up to assist in the establishment of hospitals and in transporting wounded. As with many progressive men, Hammond was also controversial. His decision, for example, to remove the dangerous mercurial medicine calomel from medical supply tables was met with vigorous and almost universal condemnation by the medical establishment, which viewed it as a panacea.

The Army Medical Museum and its rapidly growing collection of pathological specimens changed locations several times following the Civil War, for a time occupying Ford's Theater. From 1887 to 1968 the Army Medical Museum was located on the Washington Mall next to the Smithsonian. When the "red brick" museum was torn down to make room for an art museum, the public collection was transferred to Walter Reed Army Medical Center, where it is housed with its parent organization, the Armed Forces Institute of Pathology. Throughout its long history, the recently renamed National Museum of Health and Medicine of the Armed Forces Institute of Pathology has stayed true to its original purpose—a study collection for the teaching of medicine and surgery. If the National Museum of Health and Medicine has the purpose and collection of the original Army Medical Museum, then who and what is the U.S. Army Medical Museum at Fort Sam Houston?

As mentioned earlier, we are the sister institution, which has the same heritage and origins, but a different approach and mission today. As a museum, we trace our beginnings to the Medical Field Service School, established in 1920 at the location of the former Indian School at Carlisle Barracks, Pennsylvania. From 1920 to 1946 the Medical Field Service School trained Army Medical Department personnel and developed field medical equipment (the Carlisle bandage in its individual metal container, for example). In 1946 the school and its museum was relocated to Fort Sam Houston, Texas, where it became part of Brooke Army Medical Center. That same year, the Army Medical Museum was re-designated the Army Institute of Pathology. In 1949 the Army Institute of Pathology became the tri-service Armed Forces Institute of Pathology, which meant that there was no longer an official Army Medical Museum. That situation was remedied a few years later in 1955, when the Medical Field Service School Museum was renamed the U.S. Army Medical Museum. The official designation did not, however, change the perceived role of the Museum, which was the presentation of prominent medical officers and medical field equipment as both "history and tradition" and training aids for the student medical soldier.

With the creation of Health Services Command and the Academy of Health Sciences in 1973, the Medical Field Service School moved out of its quadrangle to new quarters—all, that is, except the Medical Museum in the basement of Building 2264. Health Services Command and the Academy of Health Sciences consolidated all medical training and administration for the continental United States at Fort Sam Houston. It was felt that the significant role of Fort Sam Houston in Army medicine and the museum's designation as the official Army Medical Museum warranted a better facility. In 1977 the Army Medical Department Museum Foundation was incorporated with the purpose of raising money to build a new Army Medical Museum at Fort Sam Houston. Since the United States government has not traditionally allocated funds to build Army museums, the Foundation was incorporated to raise money for the project. Upon completion of the construction, title of the building is presented to the Army, and it is then operated as an Army facility. Phase I of the construction began in May, 1988, with completion in March, 1989. Dedication of the new structure is July 24, 1989, as part of the Army Medical Department Regimental anniversary celebration.

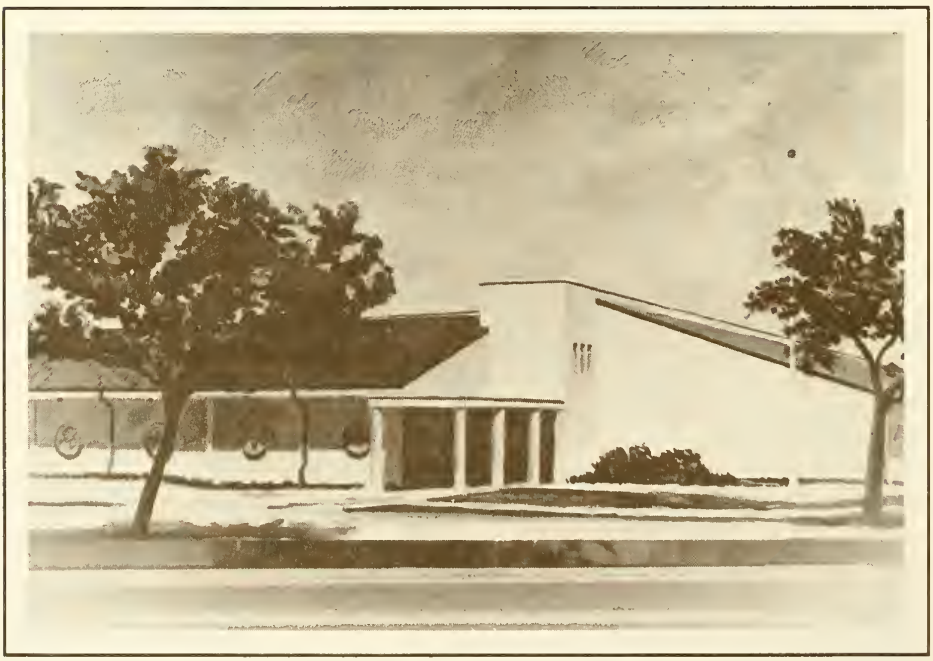
The U.S. Army Medical Museum operates as part of the Army museum system, under the Center of Military History in Washington, D.C. The Center of Military History administers 107 museums and historical holdings in both active duty and reserve component organizations worldwide. Each of these institutions has its own storyline—that part of Army history to which it

Much of the collection is made up of captured medical materiel. (Photo courtesy of U.S. Army Medical Museum.)

devotes itself and its collections. In the case of the U.S. Army Medical Museum, we have the entire history of the Army Medical Department and its activities since 1775 as a storyline. Our collection is intended to be definitive on that subject, meaning that all objects relating to Army medicine are in our domain. This Army-wide approach to collecting has already helped expand the essentially research and development collection inherited from the Medical Field Service School. We have acquired, for example, a significant collection of prisoner of war material donated by Army Medical Department personnel who were captured in the Pacific in World War II. We are also developing a collection of ambulances to trace the development of evacuation concepts. Many articles from World War II and Korea are becoming available just now, so the new building, with the attention it will generate, should be a great help in building our collection further.

With the completion of Phase I construction, the future looks both bright and challenging for the U.S. Army Medical Museum. The new building greatly expands the available exhibit space and includes service areas not possible in the old location such as an auditorium, library and gift shop. Exhibits in the old building in many cases had not been changed since the mid 1960s. This means that the exhibit plan for the new building is not just an expansion of transplanted exhibits but an all new interpretive design, incorporating the best of current museum practice.

Funds already are being raised for Phase II construction, which will provide another even larger exhibit hall and, significantly for the museum, a large storage and conservation space. The behind-the-scenes aspects of museum work are often given a low priority. Storage and conservation spaces for history museums are frequently improvised and seldom convenient to the museum itself. Phase II of the U.S. Army Medical Museum has been designed from the outset to provide adequate primary storage for the control and protection of the Museum's valuable definitive collection.



Newly completed U. S. Army Medical Museum. (Photo courtesy of U. S. Army Medical Museum.)

"There are three things to remember in real estate," as the old joke goes, "location, location and location." The new U.S. Army Medical Museum has all three. It is near the Academy of Health Sciences to serve the student population which constitutes its primary audience. It is on a prominent intersection of Fort Sam Houston, easily accessible to the Army community. Finally, the museum is near the heart of San Antonio with its huge convention and tourist trade. We are in the same neighborhood as the Fort Sam Houston

Military Museum, the San Antonio Botanical Center, the Witte Memorial Museum, and San Antonio Zoo, the McNay Art Museum and the San Antonio Museum of Art—all within a three-mile radius of downtown and a mile of each other.

As an institution the U.S. Army Medical Museum has a long and distinguished history and a significant role to play in military medical history. With the move to our new facility in 1989, it is safe to say that the best is yet to come.

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THE U.S. ARMY MEDICAL MUSEUM AT FORT SAM HOUSTON, TEXAS

Curator:	Thomas O. McMasters
Museum Technician:	Buryl D. Conger
Location:	Corner of Wurzbach and Stanley Roads, Fort Sam Houston, Texas, between the Main Hospital, Brooke Army Medical Center, and the Academy of Health Sciences. The newly completed building is in the "Spanish Revival" style with a mission tile roof and fountain courts. Large stone medallions representing the seals of the six commissioned corps, civilian, and enlisted corps decorate the facade. The location is also the site for the Combat Medic Memorial. Fort Sam Houston is surrounded by the city of San Antonio, about 2 $^1/_2$ miles from the Alamo in the heart of town. Take I-35 to New Branufels Avenue. Ft. Sam Houston exit. Go north to New Branufels Avenue, 2 blocks to the Ft. Sam Houston gate. Continue onto the post and turn right on Stanley Road and follow it about 9 blocks to the intersection with Wurzbach.
Telephone:	(512) 221-2358
Hours:	10:00 A.M. to 4:00 P.M., Wednesday through Sunday. Closed Mondays, Tuesdays and federal holidays. Official dedication is on July 24, 1989, with normal operations beginning on July 26th.
Admission:	Free

Photography Credits

U. S. Army Medical Museum

Yale Medical Historical Library

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